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SIMULATED SPACE ENVIRONMENTAL TESTS ON CADMIUM SULFIDE SOLAR CELLS

D180-12700-1

FINAL REPORT

DAVID R. CLARKE – TECHNICAL LEADER
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PREPARED FOR NASA-LEWIS RESEARCH CENTER
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CONTRACT NAS3-11838

THE BOEING COMPANY, AEROSPACE GROUP, KENT FACILITY
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THE BOEING COMPANY
AEROSPACE GROUP
KENT FACILITY
P.O. BOX 3999 SEATTLE, WASHINGTON 98124

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16. Abstract

Cadmium sulfide (Cu_2S - CdS) solar cells were tested under simulated space environmental conditions. Some cells were thermally cycled with illumination from a Xenon-arc solar simulator. A cycle was one hour of illumination followed immediately with one-half hour of darkness. In the light, the cells reached an equilibrium temperature of 60°C (333°K) and in the dark the cell temperature dropped to -120°C (153°K). Other cells were constantly illuminated with a Xenon-arc solar simulator. The equilibrium temperature of these cells was 55°C (328°K). The black vacuum chamber walls were cooled with liquid nitrogen to simulate a space heat sink. Chamber pressure was maintained at 10^{-6} torr or less. Almost all of the solar cells tested degraded in power when exposed to a simulated space environment of either thermal cycling or constant illumination. The cells tested the longest were exposed to 10,050 thermal cycles.

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ABSTRACT

Cadmium sulfide (Cu_2S-CdS) solar cells were tested under simulated space environmental conditions. Some cells were thermally cycled with illumination from a Xenon-arc Solar Simulator. A cycle was one hour of illumination followed immediately with one-half hour of darkness. In the light, the cells reached an equilibrium temperature of 60°C (333°K) and in the dark the cell temperature dropped to -120°C (153°K). Other cells were constantly illuminated with a Xenon-arc Solar Simulator. The equilibrium temperature of these cells was 55°C (328°K). The black vacuum chambers walls were cooled with liquid nitrogen to simulate a space heat sink. Chamber pressure was maintained at 10^{-6} torr or less. Almost all of the solar cells tested degraded in power when exposed to a simulated space environment of either thermal cycling or constant illumination. The cells tested the longest were exposed to 10,050 thermal cycles.

1.0 SUMMARY

This document reports the results of testing cadmium sulfide (Cu_2S-CdS) solar cells in a simulated space environment from March, 1969 thru July 12, 1971 under contract NAS3-11838 with the Lewis Research Center.

CdS solar cells were tested under different simulated space environmental conditions in two vacuum chambers. Some cells were thermally cycled with illumination from a Xenon-Arc Solar Simulator. A cycle was one hour of illumination followed immediately with one more hour of darkness. In the light the cells reached an equilibrium temperature of 60°C (333°K) and in the dark the cell temperature dropped to -120°C (153°K). Other cells were constantly illuminated with a Xenon-Arc Solar Simulator. The equilibrium temperature of these cells was 55°C (328°K). The black walls of the vacuum chambers were cooled with liquid nitrogen to simulate a space heat sink. The pressure in the chamber was maintained at 10^{-6} torr.

In Table 1 the results of the thermal cycling tests are shown for the Groups A, B and C cells. The data in this table indicate that at the end of the test the degradation in power of the Group A cells ranged from +2 to -22%; Group B cells from -11 to -24%; and Group C cells from -6 to -29% of their initial values. The Group B cells were thermally cycled for 10,050 cycles, which is the longest thermal cycling test of CdS cells to date.

In Table 1A the results of the constant illumination tests are shown for the Group D, E and F cells. The data indicate that at the end of the test the degradation in power of the six cell series string was 25% and was in agreement with the degradation of the individual Group D cells. The degradation of the Group E, May 1969 cells ranged from -11 to -16%; the June 1969 from -3 to -6%; and the June 1970 from -16 to -25% of their initial values. The degradation of the Group F, January 1969 cells was -10%; the June 1969 cells ranged from -6 to -8%; the June 1970 cells ranged from -19 to -23% of their initial values.

The data in these tables indicate that almost all of the CdS solar cells tested degraded in power when exposed to a simulated space environment involving either thermal cycling or constant illumination.

Table 1: SUMMARY OF CONSTRUCTION AND PERFORMANCE OF CdS SOLAR CELLS TESTED

GROUP (CHAMBER NUMBER)	NUMBER OF CELLS	BOEING NUMBER	MANUFACTURER'S NUMBER	MANUFACTURE DATE	SUBSTRATE	TYPE TEST	NUMBER OF 90-MINUTE THERMAL CYCLES OR HOURS OF CONSTANT ILLUMINATION	POWER AT 60°C CYCLE 1 (MW) [1]	EFFICIENCY AT 60°C CYCLE 1 (PERCENT)	POWER AT 60°C END CYCLE (MW)	EFFICIENCY AT 60°C END CYCLE (PERCENT)	CHANGE IN POWER (PERCENT)	METHOD OF TAKING DATA
A (4)	1 INDIVIDUAL CELL	1	N153AK7	MARCH 1968	SPRAY COATED KAPTON	THERMAL CYCLE	2124 CYCLES	182	2.38	154	2.00	-16	I-V TRACES
	4 INDIVIDUAL CELLS	2 3 4 5	N319BK2 N310CK9 N315BK4 N311BK4	NOVEMBER 1968	SPRAY COATED KAPTON	THERMAL CYCLE	2124 CYCLES	191 180 177 184	2.48 2.34 2.30 2.39	172 140 180 186	2.24 1.82 2.34 2.42	-10 -22 + 2 + 1	I-V TRACES
B (4)	4 INDIVIDUAL CELLS	6 7 8 9	N319BK4 N310BK7 N315BK1 N311AK1	NOVEMBER 1968	SPRAY COATED KAPTON	THERMAL CYCLE	10,050 CYCLES	198 182 199 192	2.57 2.37 2.59 2.50	150 146 177 152	1.95 1.90 2.30 1.98	-24 -20 -11 -21	VOLTAGE AT FIXED LOAD
C (4)	3 INDIVIDUAL CELLS	19 20 21	91154 91746 88861	JUNE 1969	SPRAY COATED KAPTON	THERMAL CYCLE	7,926 CYCLES	172 177 187	2.24 2.30 2.43	129 166 133	1.68 2.16 1.73	-25 - 6 -29	VOLTAGE AT FIXED LOAD
	2 INDIVIDUAL	22 23	81-8-6-5 8-2-0-4-5	JUNE 1969	ROLL COATED	THERMAL CYCLE	7,926 CYCLES	199 212	2.59 2.76	181 195	2.36 2.54	- 9 - 8	VOLTAGE AT FIXED LOAD

NOTES: ALL CELLS HAD GOLD-PLATED COPPER GRIDS BONDED ON WITH CONDUCTING EPOXY, AND WERE ENCAPSULATED IN KAPTON

[1] AS MEASURED INSIDE CHAMBER WITH $<10^{-6}$ TORR PRESSURE. EACH CELL WAS LOADED AT ITS MAXIMUM POWER POINT

Table 1A: SUMMARY OF CONSTRUCTION AND PERFORMANCE OF CdS SOLAR CELLS TESTED

GROUP (CHAMBER NUMBER)	NUMBER OF CELLS	BOEING NUMBER	MANUFACTURER'S NUMBER	MANUFACTURE DATE	SUBSTRATE	TYPE TEST	NUMBER OF HOURS OF CONSTANT ILLUMINATION	POWER AT 55°C AT 2 HOURS OF TEST (MW) (2)	EFFICIENCY AT 55°C AT 2 HOURS (PERCENT)	POWER AT 55°C AT END OF TEST (MW) (2)	EFFICIENCY AT 55°C AT END OF TEST (PERCENT)	CHANGE IN POWER (PERCENT)	METHOD OF TAKING DATA
D (2)	6 CELLS IN SERIES STRING	29 30 31 32 33 34	119-7-4-6D 117-7-4-8D 117-6-5-9C 119-8-6-8E 119-8-6-7E 130-7-6-2B	SEPTEMBER 1969	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	6,321 HOURS (1)						VOLTAGE AT FIXED LOAD
	SERIES STRING							1,265	2.78	949	2.05	-25	
	3 INDIVIDUAL CELLS	35 36 37	130-4-4-4A 119-7-4-5D 117-6-5-5C	SEPTEMBER 1969	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	6,321 HOURS (1)	219 237 237	2.85 3.08 3.08	169 180 194	2.20 2.34 2.52	-23 -24 -18	VOLTAGE AT FIXED LOAD
E (2)	3 INDIVIDUAL CELLS	56 57 58	64265 64445 72559	MAY 1969	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	2,646	192 175 184	2.50 2.27 2.39	170 146 162	2.21 1.90 2.11	-11 -16 -12	VOLTAGE & CURRENT AT FIXED LOAD
	2 INDIVIDUAL	59 60	81156 82251	JUNE 1969	ROLL COATED	CONSTANT ILLUMINATION	2,646	202 193	2.63 2.51	189 187	2.46 2.43	- 6 - 3	VOLTAGE & CURRENT AT FIXED LOAD
	4 INDIVIDUAL CELLS	61 62 63 64	299861C 300861F 298644D 300867F	JUNE 1970	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	2,646	211 209 202 201	2.74 2.72 2.63 2.61	171 176 152 159	2.22 2.29 1.98 2.07	-19 -16 -25 -21	VOLTAGE & CURRENT AT FIXED LOAD
F (4)	3 INDIVIDUAL CELLS	47 48 49	N361CK2 N362CK7 N359AK6	JANUARY 1969	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	2,639	186 184 184	2.42 2.39 2.39	168 165 165	2.18 2.14 2.14	-10 -10 -10	VOLTAGE & CURRENT AT FIXED LOAD
	2 INDIVIDUAL CELLS	50 51	81762 81763	JUNE 1969	ROLL COATED	CONSTANT ILLUMINATION	2,639	186 203	2.42 2.64	175 186	2.27 2.42	- 6 - 8	VOLTAGE & CURRENT AT FIXED LOAD
	4 INDIVIDUAL CELLS	52 53 54 55	301544D 300143D 294446D 298767C	JUNE 1970	SPRAY COATED KAPTON	CONSTANT ILLUMINATION	2,639	197 203 200 200	2.56 2.64 2.60 2.60	154 165 156 155	2.00 2.14 2.03 2.01	-22 -19 -22 -23	VOLTAGE & CURRENT AT FIXED LOAD

NOTES:

(1) PRECEDED BY 227 THERMAL CYCLES

(2) ALL CELLS HAD GOLD-PLATED GRIDS BONDED ON WITH CONDUCTING EPOXY, AND WERE ENCAPSULATED IN KAPTON AS MEASURED INSIDE CHAMBER WITH $< 10^{-6}$ TORR PRESSURE. EACH CELL WAS LOADED AT ITS MAXIMUM POWER POINT

Control cells, kept in double-desiccated storage in a laboratory cabinet, were tested from time to time to verify the amount of test cell degradation. However, test cell output, measured under a one-sun intensity of illumination, was the basic data from which degradation was calculated. The solar simulation was periodically calibrated against a NASA-Lewis-furnished airplane-flown CdS standard cell.

2.0 INTRODUCTION

Development of cadmium sulfide (CdS) thin-film solar cells started in 1954 (Reference 1). By 1960 conversion efficiencies as high as 3-1/4 percent had been achieved, and CdS solar cells began to look promising as sources of power for spacecraft. In 1963 the NASA Lewis Research Center (NASA Lewis) began to evaluate new CdS solar cell designs in the vacuum and thermal environment of space (References 2 and 3). These tests soon showed that the early CdS solar cells degraded very quickly when subjected to thermal cycling in vacuum, as would be encountered by an Earth satellite. Thus, thermal cycling became established as an important test for evaluating new cell designs.

In 1964 NASA Lewis awarded a 2-phase contract (NAS3-6008) to The Boeing Company (Boeing) for conducting thermal cycling tests on promising new CdS solar cell designs, after the new designs had been screened in similar tests at NASA Lewis. In these thermal cycling tests the cells were subjected to alternating periods of sunlight and darkness with temperatures varying from approximately -100°C (173°K) to +60°C (333°K) (Reference 4). The thermal cycling tests at NASA Lewis and Boeing uncovered weaknesses in the cell design and gave direction to the design and construction of more stable cells. Concurrently the cell manufacturer increased the conversion efficiency of CdS solar cells.

In 1969 a second contract (NAS3-11838) was awarded to Boeing for thermal cycling on new and improved CdS solar cells, and in 1970 this contract was expanded to include testing in two test chambers. This document reports the results of work done by Boeing for NASA Lewis on Contract NAS3-11838 through July, 1971.

In the first fourteen months of the contract period one chamber and one X-25L solar simulator were used for testing, and only nine solar cells could be tested at one time. The contract was expanded in March 1970 to include a second vacuum chamber and a second solar simulator. The second chamber could also test nine cells, and after the first two weeks of thermal cycling the second test was changed to constant illumination. In February 1971, both tests were stopped and the cells were replaced with new cells. The new tests were done with constant illumination and were concluded in July 1971.

A X-25L Solar Simulator provided the irradiation for the thermal cycling test of the Group A, B and C cells which were tested in chamber number 4. At first the Group A and Group B cells were tested together, but at cycle 2124 the Group A cells were replaced with the Group C cells. At the conclusion of the Group B and C cell test, the Group F cells were put into the chamber and were tested under constant illumination.

A X-25L Mark II Solar Simulator provided the irradiation for the constant illumination test of the Group D and the Group E test cells which were tested in chamber number 2. The Group D cells were at first thermal cycled for 227 cycles and then the test was changed to constant illumination with no interruption in testing. Six of the Group D cells were in a series string and the three remaining cells were individual. The solar cells in the Group D series string were the only cells in this entire test that were connected together in a string. At the conclusion of the Group D cell test, the Group E cells were put into the chamber and were tested under constant illumination.

CdS solar cells were mounted nine at a time in a vacuum chamber maintained at a pressure of less than 10^{-6} torr. Through a quartz window the cells were illuminated by a light source that closely simulated the solar spectrum in space. The black walls of the chamber were cooled with liquid nitrogen so that the cell temperature dropped to -120°C (153°K) during the dark portion of each cycle and came to an equilibrium of about +60°C (333°K) during the illuminated portion of each cycle. A complete thermal cycle consisted of 30 minutes of darkness followed by 60 minutes of illumination. Performance of the cells was usually measured about once every 100 cycles, but more frequently whenever cycling of the new cells was started. During the constant illumination tests the cells were maintained at an equilibrium temperature of about +55°C (328°K). Performance of the cells was usually measured about once every 150 hours, but more frequently whenever cycling of the new cells was started. A matching set of CdS solar cells was kept in double-desiccated storage through the test, and their performance was also measured every 100 cycles during the thermal cycling tests. In this report, the CdS solar cells exposed to the space environment are referred to as "test cells". Those kept in double-desiccated storage are referred to as "control cells".

3.0 TEST APPARATUS

In this section is described the apparatus that provides the test environment and the equipment used in acquisition of data.

3.1 Test Environment

The test facilities consisted of two vacuum chambers, two solar simulators, two test-cell supporting frames, two control-cell mounting blocks, and instruments for measuring light intensity and spectra. The test-cell supporting frames locate the test cells in the test plane of the vacuum chamber during testing. Cell heaters are suspended directly behind the solar cells. The control-cell mounting blocks, used to hold the control cells when their performance is being measured, are outside the vacuum chamber. The solar simulators are mounted on platforms so that they can be rotated to illuminate the test cells, or the control cells, or the light intensity and spectrum measuring devices.

In Figure 1 a schematic of the test set-up for the Groups A, B, C, and F cells is shown. The setup for the Group D and E cells is similar except that the axis of the vacuum chamber was vertical rather than horizontal. Photographs of the setups are shown in Figures 2 and 3.

3.1.1 Vacuum Chamber

Each vacuum chamber is composed of a shell, a cold shroud, an end plate, an access door, a quartz window, a mounting bracket for the test cell supporting frame, a solar cell heater, and a vacuum pump.

The shell of the chamber number 4 was built from two stainless steel cylinders, one 15 inches (38.1 cm) in diameter and 41 inches (104.1 cm) long, and the other 34 inches (86.4 cm) in diameter and 30 inches (76.2 cm) long. The smaller diameter end is sealed with a quartz window through which the CdS cells are illuminated. The other end has an access door. Vacuum is maintained by an ion pump located under the shell.

The shell always remains at near room temperature. A heat sink simulating the space environment within the chamber is provided by a cold shroud composed of two aluminum cylinders of different diameters joined end-to-end. The cold shroud fits inside the shell with a two-inch concentric gap between the shroud and the shell, and is essentially isolated thermally from the shell, being supported at only 5 points with low thermal-conductivity stainless steel. The shroud is cooled to -196°C (77°K) during testing by pumping liquid nitrogen through tubes which are integral with the shroud. All inner surfaces of the shroud are painted black to reduce reflection of thermal radiation. Liquid-nitrogen cooled baffles inside the shroud further reduce reflections.

A blackened aluminum plate bolted to the end of the cold shroud, cooled to -160°C (113°K) by conduction to the cold shroud, covers the cell access opening during testing. The chamber is sealed, at the cell-access end, with a stainless steel door which is bolted against a copper gasket that is replaced whenever the door is opened.

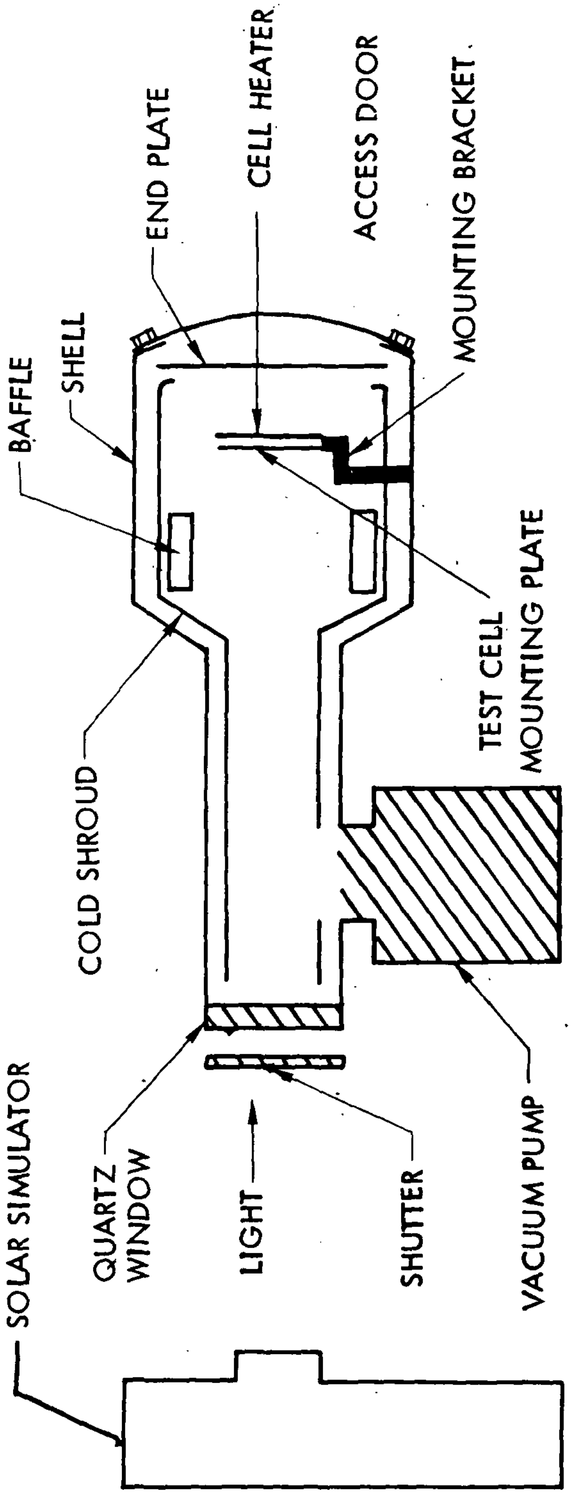

Figure 1: ARRANGEMENT OF TEST CHAMBER

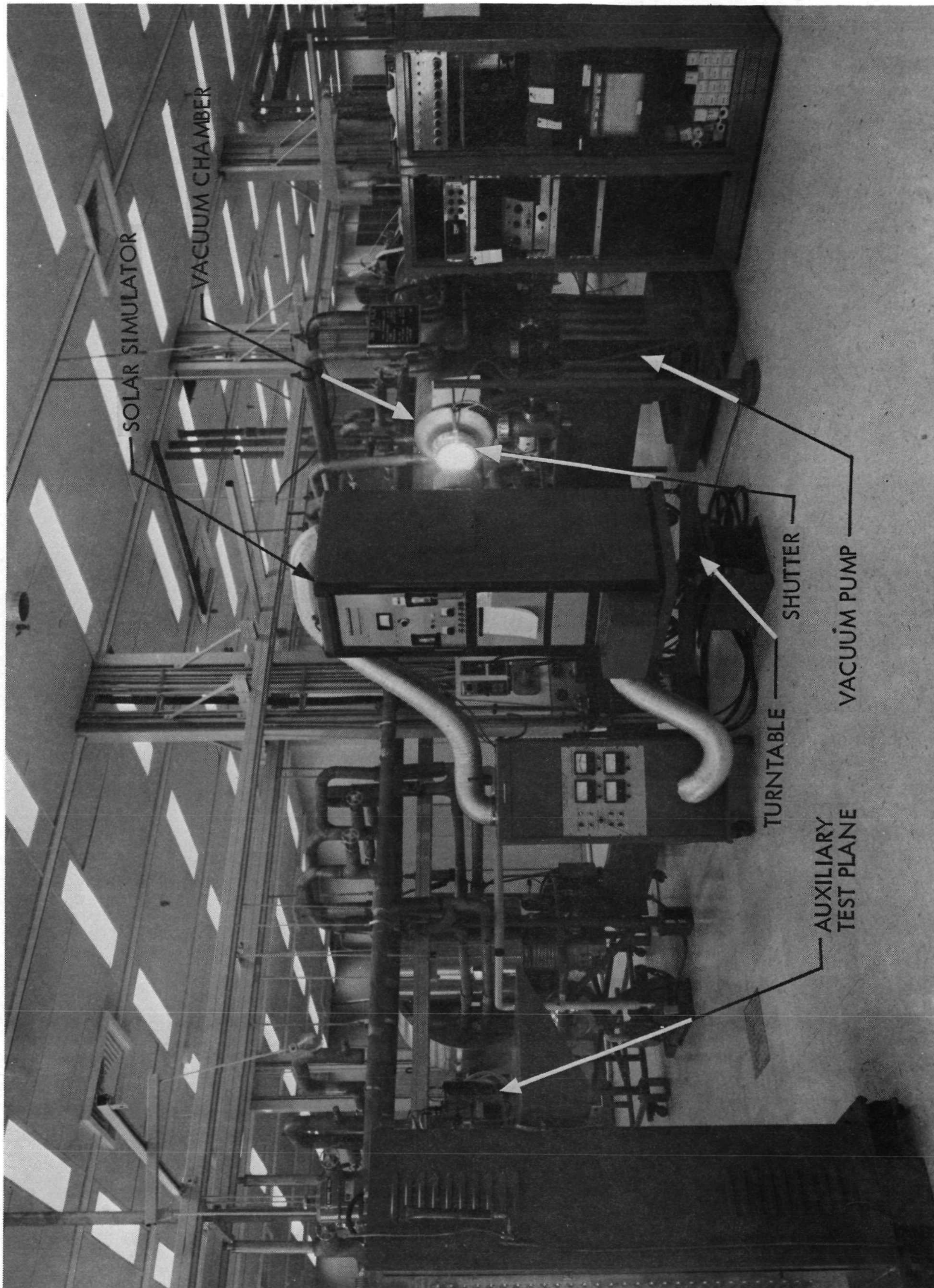

Figure 2: HORIZONTAL VACUUM CHAMBER AND SOLAR SIMULATOR

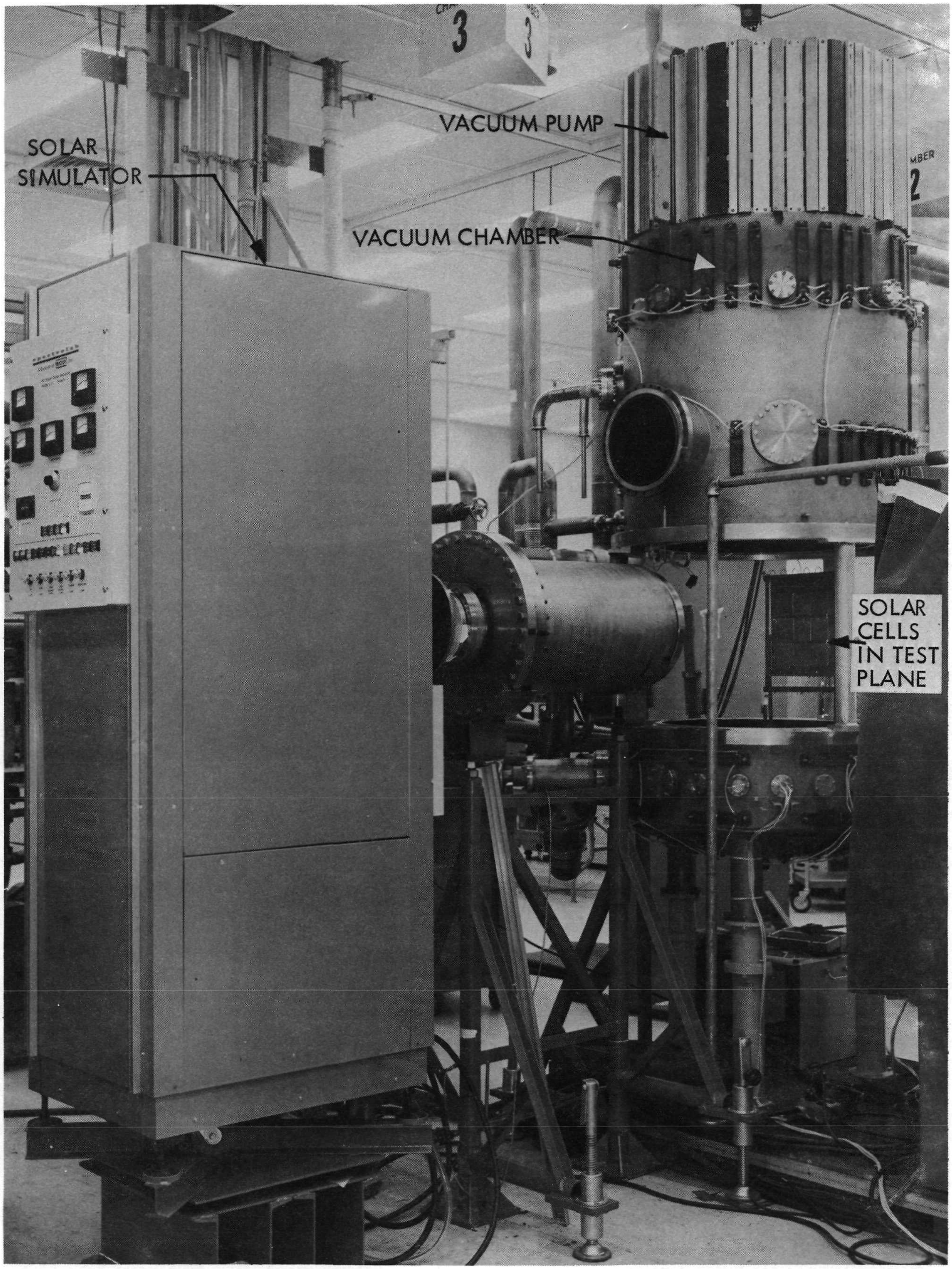

Figure 3: VERTICAL VACUUM CHAMBER WITH TOP RAISED

The quartz window which admits simulated sunlight into the chamber transmits 94 percent of the ultraviolet energy in the wavelength band of 0.25 to 0.35 microns. Transmission in other wave lengths ranges from 88.3 percent to 96.7 percent, as shown in Table 2, and Figure 4.

A shutter between the solar simulator and the quartz window interrupts the light beam when the test cells in the chamber are to receive no light from the solar simulator. The shutter is painted black to reduce reflection of room light from the shutter into the chamber. Furthermore, the shutter is water-cooled to reduce the infrared energy radiated by the shutter into the chamber. During cycling in chamber number 4, the shutter automatically blocks the light for 30 minutes and uncovers the light for 60 minutes.

A mounting bracket supports the test-cell frame in the chamber. The mounting bracket is fastened only to the shell and makes no contact with the cold shroud. It is made of low-thermal-conductivity stainless steel, to restrict heat conduction to the shell.

Tantalum wire heaters (Figure 5) were mounted in the vacuum chamber 1.5 inches (3.8 cm) behind the test plane. The 0.020 inch (0.5 mm) diameter wires run vertically on 1-inch (2.54 cm) centers in an aluminum frame to form a 12 by 12 inch (30.5 by 30.5 cm) array. There are two separate heaters in the frame, one active and one standby. The heaters supplement the solar simulation in maintaining cell temperature. The solar simulator spectrum changes as its lamp and optics age as shown in Figure 6. As a result, the total radiation received by the test cells usually falls off even though one solar constant, as seen by a CdS standard cell, is still irradiating the cells. The heaters make up this radiation deficiency to keep the test cells at their predicted space temperature, thus minimizing the temperature corrections required when the data are normalized.

A mechanical roughing pump and an ion pump are used to establish vacuum. The roughing pump decreases the chamber pressure to 10^{-4} torr, after which the ion pump is started and the roughing pump is removed. The ion pump maintains a pressure of 10^{-8} torr during testing when the shroud is cooled with liquid nitrogen and 10^{-6} torr during test interruptions when the shroud is at room temperature. The pressure increases during test interruptions when gas is released by the warming shroud surface.

3.1.2 Light Source

The light source for chamber number 4 was a Spectrolab X-25L filtered-Xenon solar simulator, equipped with lenticular optics to provide uniform illumination at the test plane, and special filters to provide a spectrum closely matching that of space sunlight. The solar simulator is spaced away from the vacuum chamber (Figure 2) to illuminate a 13 1/4 inch (33.6 cm) diameter test plane containing nine 3 by 3 inch (7.6 by 7.6 cm) test cells in the chamber. The spectrum of the light beam closely matches Johnson's space spectrum (Reference

TABLE 2: TRANSMISSION OF QUARTZ WINDOW

WAVELENGTH BAND (μ)	FRACTION OF INCIDENT LIGHT ENERGY TRANSMITTED THROUGH QUARTZ WINDOW (percent)
0.25 - 0.35	93.9
0.35 - 0.40	95.2
0.40 - 0.45	92.5
0.45 - 0.50	96.4
0.50 - 0.60	94.8
0.60 - 0.70	92.8
0.70 - 0.80	95.2
0.80 - 0.90	92.3
0.90 - 1.00	96.7
1.00 - 1.20	95.7
1.20 - 1.50	93.0
1.50 - 1.80	91.1
1.80 - 2.20	88.3
2.20 - 2.50	90.5

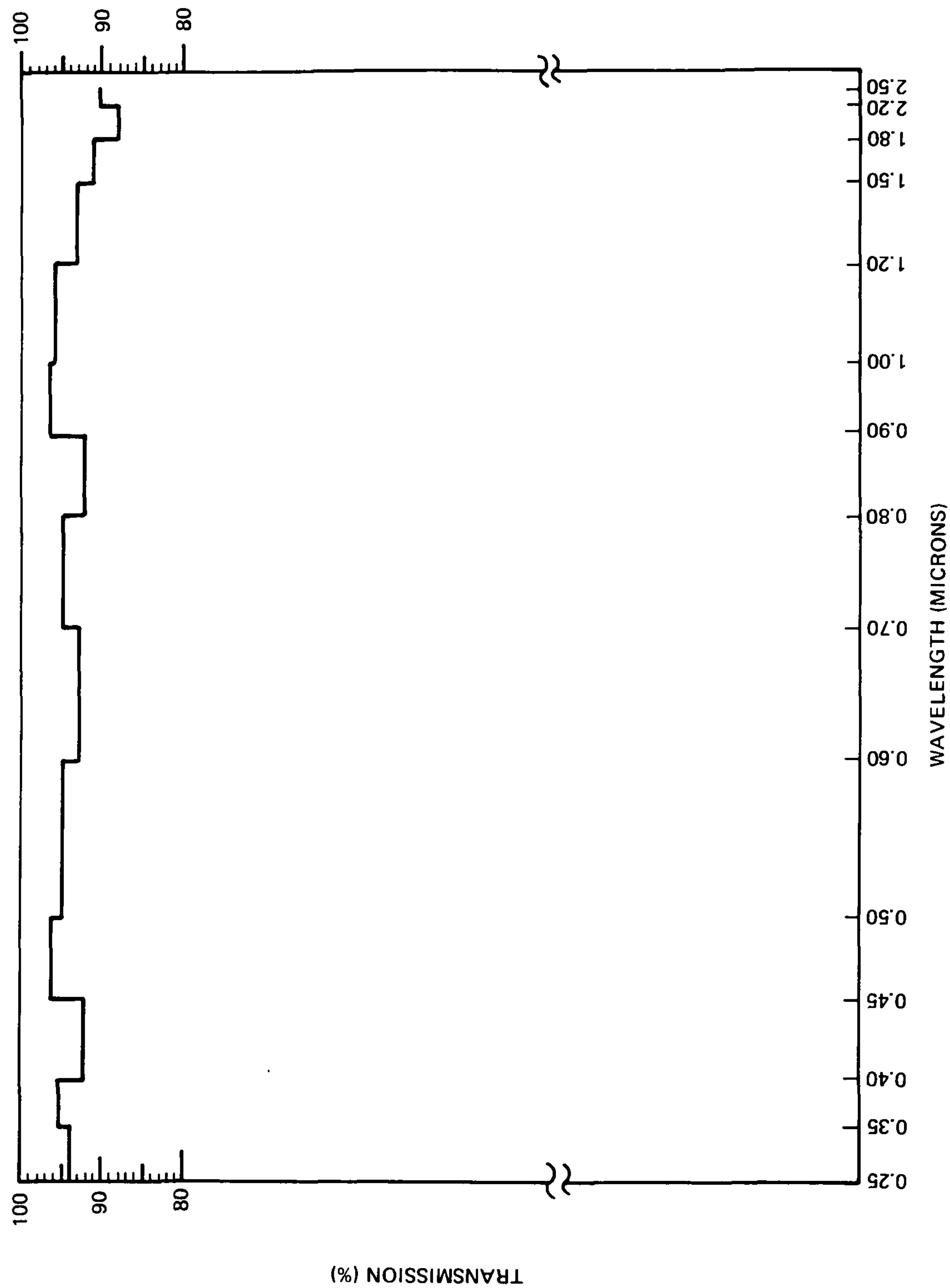

Figure 4: TRANSMISSION OF QUARTZ WINDOWS USED ON VACUUM CHAMBERS

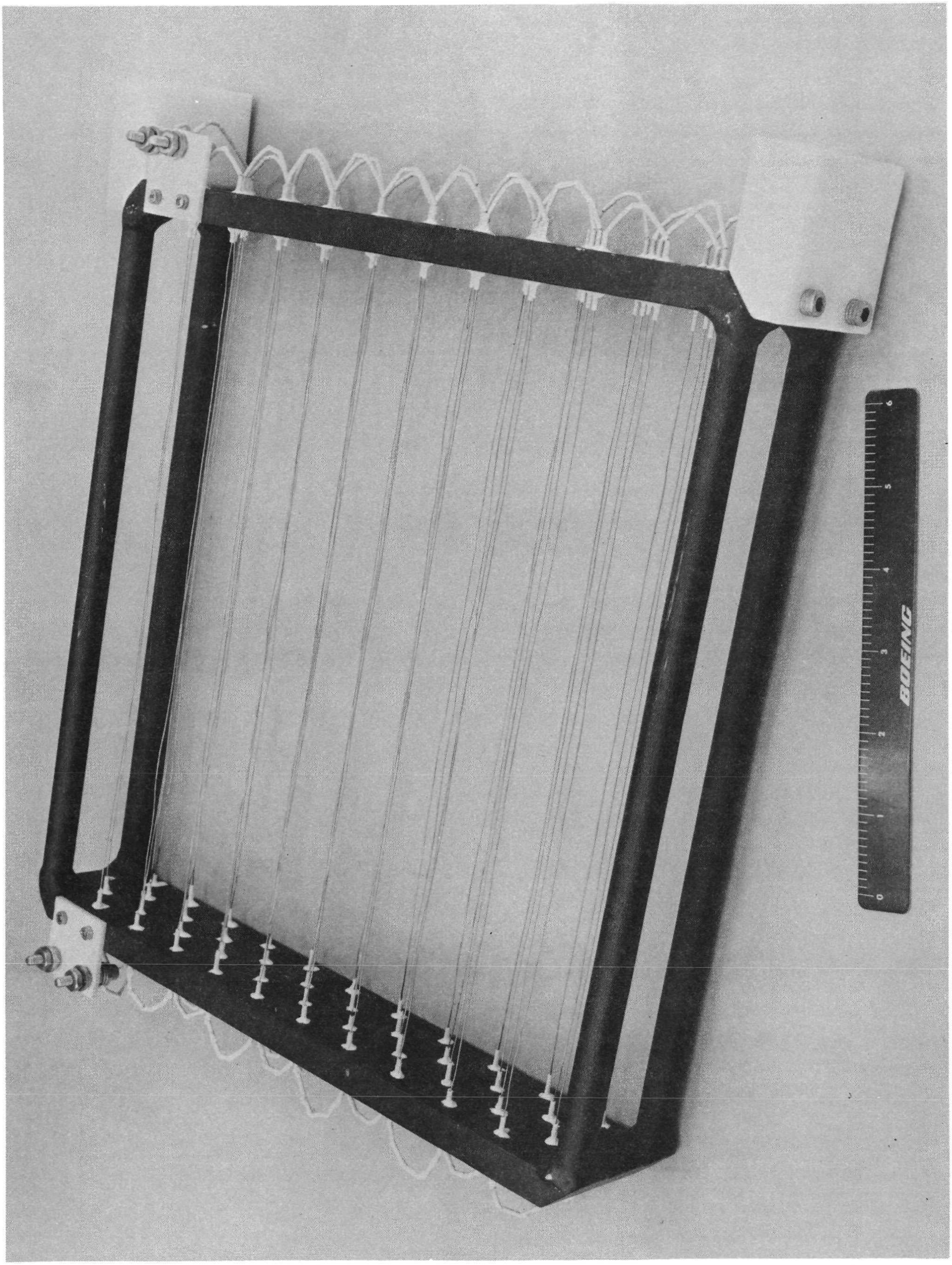

Figure 5: TANTALUM WIRE HEATER

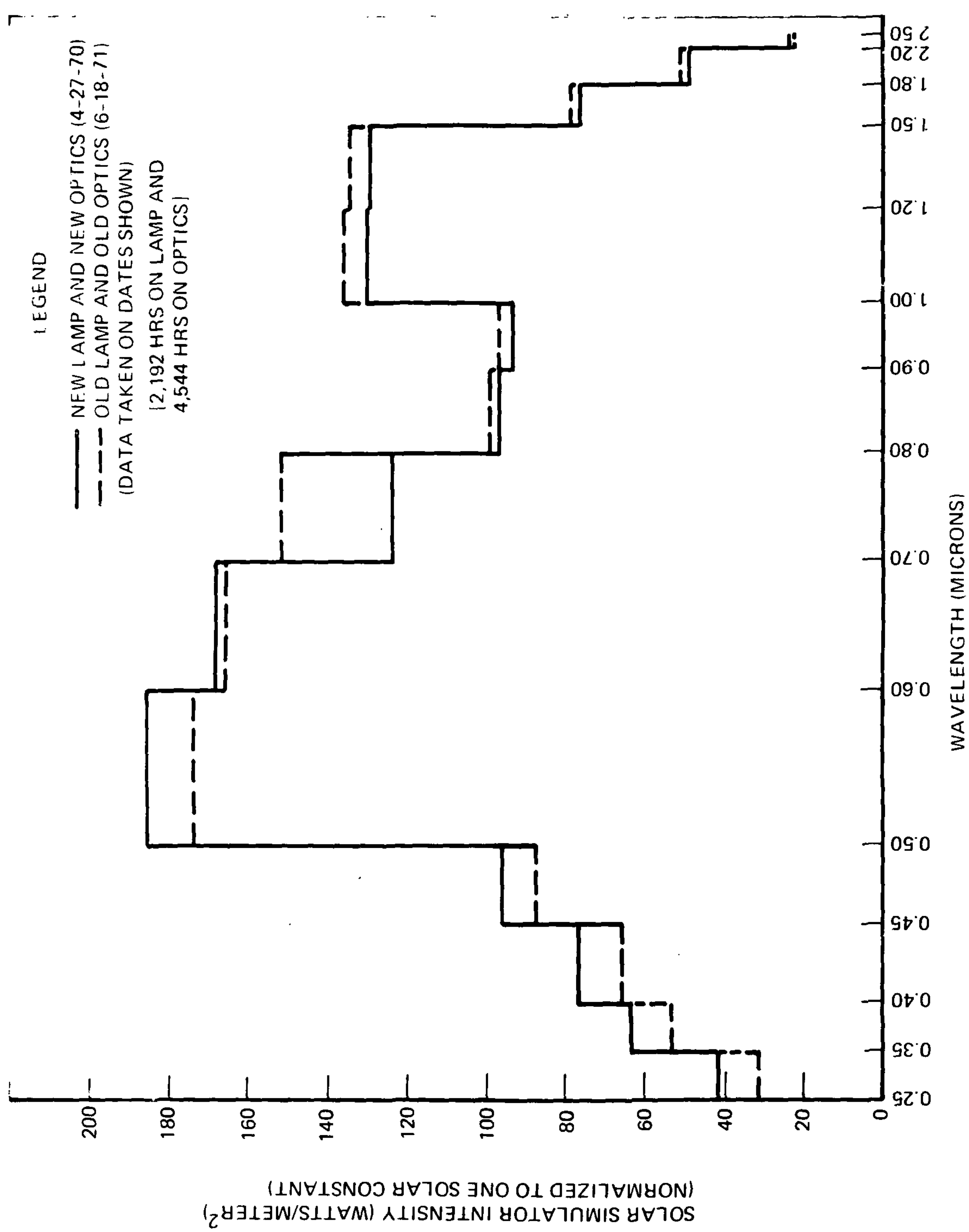

Figure 6: INTENSITY OF X-25L MARK II SOLAR SIMULATOR WITH NEW AND OLD LAMP AND OPTICS

5) as shown by the typical spectrum in Table 3 and Figure 7. The intensity at any area in the test plane did not deviate from that in the center by more than plus or minus two percent as shown in a typical uniformity plot in Figure 8. The simulator intensity was frequently adjusted, using an airplane-flown CdS standard cell provided by NASA Lewis, to maintain at the test plane an intensity equivalent to one solar constant at air mass zero (AMO) (Reference 6). The intensity was also checked periodically with a radiometer that had been calibrated at Table Mountain, California (Reference 7).

A Spectrolab X-25L Mark II solar simulator was used for chamber number 2. A typical Mark II spectrum is provided in Table 4 and a typical uniformity plot is shown in Figure 9. The intensity of the Mark II solar simulator was likewise maintained at one solar constant, using the airplane-flown CdS standard cell.

3.1.3 Test-Cell Supporting Frame

A disc-shaped, glass-epoxy circuit-board, with a rectangular cutout in its middle, was used to hold the test cells in chamber number 4. The negative electrode of each cell was attached with double-backed tape to cross bars which spanned the cutout. Each cell hung freely, with its positive electrode constrained within a 1/16-inch (1.6 cm) slot in a cross bar beneath it. The frame was painted black. Two silicon solar cells (reference cells) were mounted on the front surface. The test-cell supporting frame was held in the vacuum chamber by a stainless steel mounting bracket.

3.1.4 Control Cell Mounting Block

Chamber number 4 control cells, whenever tested for electrical performance, were mounted on the control-cell mounting block (Figure 10) and illuminated with the X-25L solar simulator. The temperature of the metal mounting block is controlled by recirculating water. Good thermal contact between the block and the control cell is obtained by applying vacuum to grooves in the front of the block. Electrical contact to the cell is made with spring clips. This mounting block and the airplane-flown CdS standard cell are supported on a plate that can be slid to the center of the light beam.

The chamber number 4 control-cell mounting block was also used with the X-25L solar simulator for checking the individual control cells for chamber number 2, because the continuous illumination in chamber number 2 could not be interrupted for the time required to measure the control-cell performance. The performance of the six series connected CdS control cells was measured on a larger control-cell mounting block located at an auxiliary test plane of the X-25L Mark II solar simulator (Figure 11). The temperature of this aluminum mounting block is controlled by recirculating water. Good thermal contact between the block and the control cells was assured by applying vacuum to the holes in the front of the block. Electrical contact to the cells was made with spring clips.

Table 3: TYPICAL SPECTRAL INTENSITY OF X-25L SOLAR SIMULATOR

The table below depicts spectral data both relatively and in watts/meter^2 for the solar simulator. The % deviations with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in the right-hand column.

Band No.	Band (microns)	Sensor Reading	Sensor Reading Normalized to One Solar Constant (w/m^2)	NRL (w/m^2)	% Deviation
1.	0.25 0.35	4.8	24.3	62.82	-61.3
2.	0.35 0.40	10.1	51.2	61.42	-16.7
3.	0.40 0.45	13.1	66.4	95.90	-30.8
4.	0.45 0.50	18.0	91.2	106.10	-14.1
5.	0.50 0.60	39.3	199.1	191.25	+ 4.1
6.	0.60 0.70	37.6	190.5	161.94	+17.6
7.	0.70 0.80	24.3	123.1	127.03	- 3.1
8.	0.80 0.90	17.3	87.6	100.52	-12.8
9.	0.90 1.00	17.2	87.1	80.96	+ 7.6
10.	1.00 1.20	26.1	132.2	121.46	+ 8.9
11.	1.20 1.50	26.2	132.7	111.68	+18.8
12.	1.50 1.80	15.8	80.8	61.84	+29.4
13.	1.80 2.20	10.5	53.2	44.25	+20.2
14.	2.20 2.50	5.4	27.4	19.13	+43.0

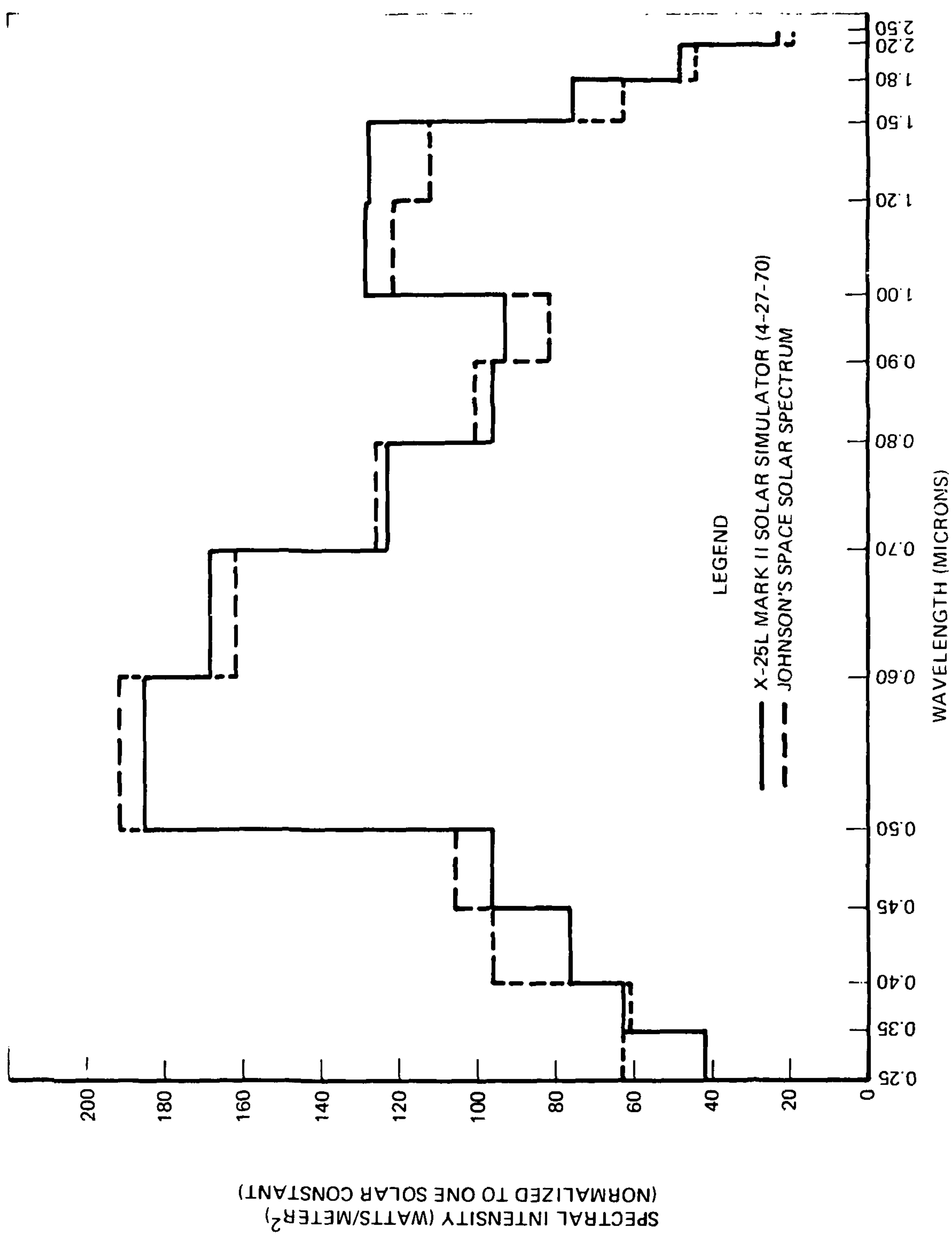

Figure 7: COMPARISON OF THE X-25L MARK II SOLAR SIMULATOR SPECTRUM WITH JOHNSON'S SOLAR SPECTRUM

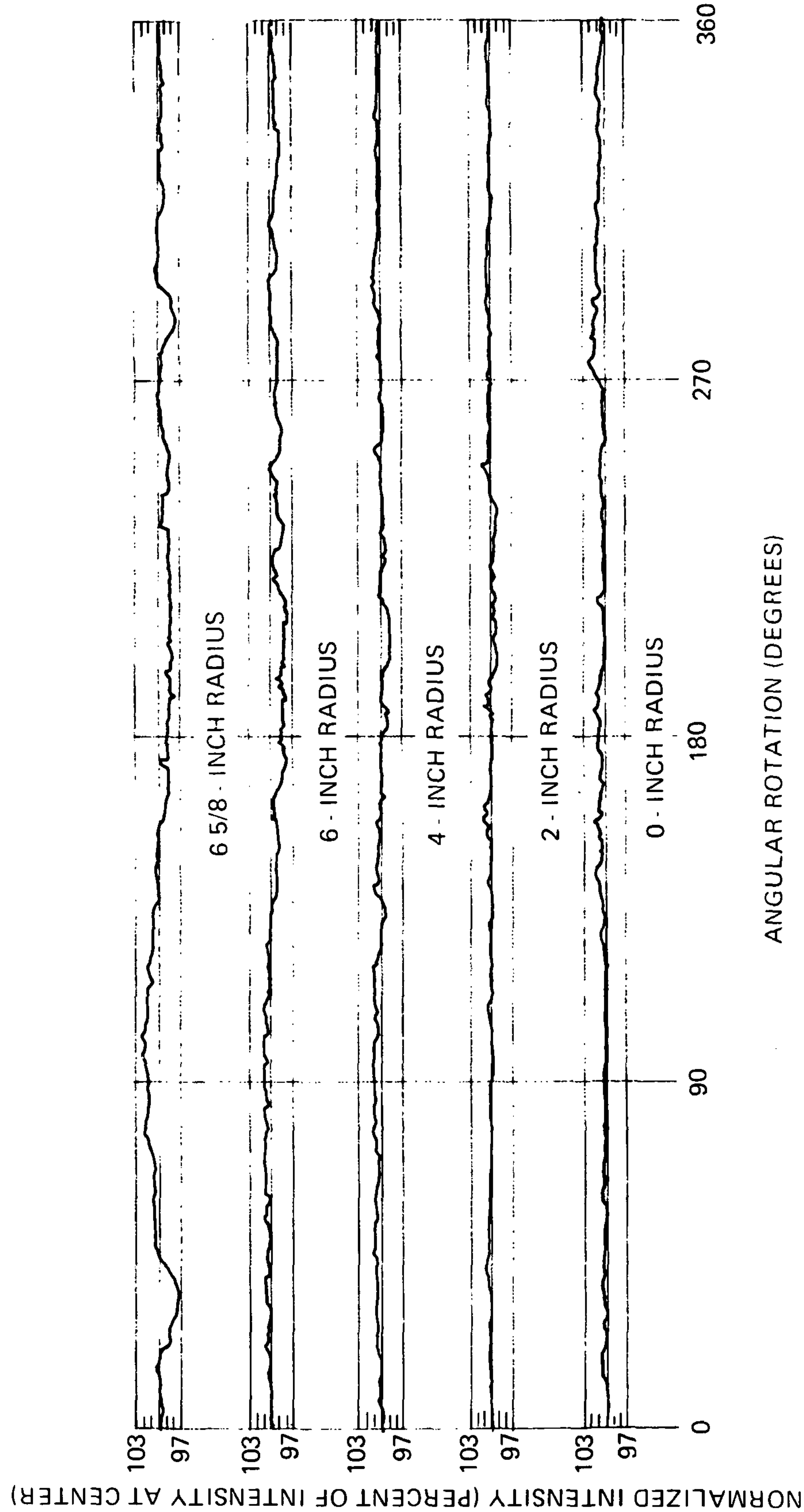

Figure 8 : SOLAR SIMULATOR UNIFORMITY SCANS FOR X-25L

Table 4: TYPICAL SPECTRAL INTENSITY OF X-25L, MARK II SOLAR SIMULATOR

The table below depicts spectral data both relatively and in watts/meter^2 for the solar simulator. The % deviations with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in the right-hand column.

Band No.	Band (microns)		Sensor Reading	Sensor Reading Normalized to One Solar Constant (w/m^2)	NRL (w/m^2)	% Deviation
1.	0.25	0.35	8.1	41.4	62.82	-34.2
2.	0.35	0.40	12.3	62.8	61.42	+ 2.3
3.	0.40	0.45	14.9	76.1	95.90	-20.7
4.	0.45	0.50	18.7	95.5	106.10	-10.0
5.	0.50	0.60	36.2	184.8	191.25	- 3.3
6.	0.60	0.70	33.0	168.5	161.94	+ 4.1
7.	0.70	0.80	24.1	123.1	127.03	- 3.1
8.	0.80	0.90	18.8	96.0	100.52	- 4.5
9.	0.90	1.00	18.3	93.4	80.96	+15.4
10.	1.00	1.20	25.3	129.2	121.46	+ 6.4
11.	1.20	1.50	25.2	128.7	111.68	+15.2
12.	1.50	1.80	14.8	75.6	61.84	+22.2
13.	1.80	2.20	9.5	48.5	44.25	+ 9.6
14.	2.20	2.50	4.4	22.5	19.13	+17.4

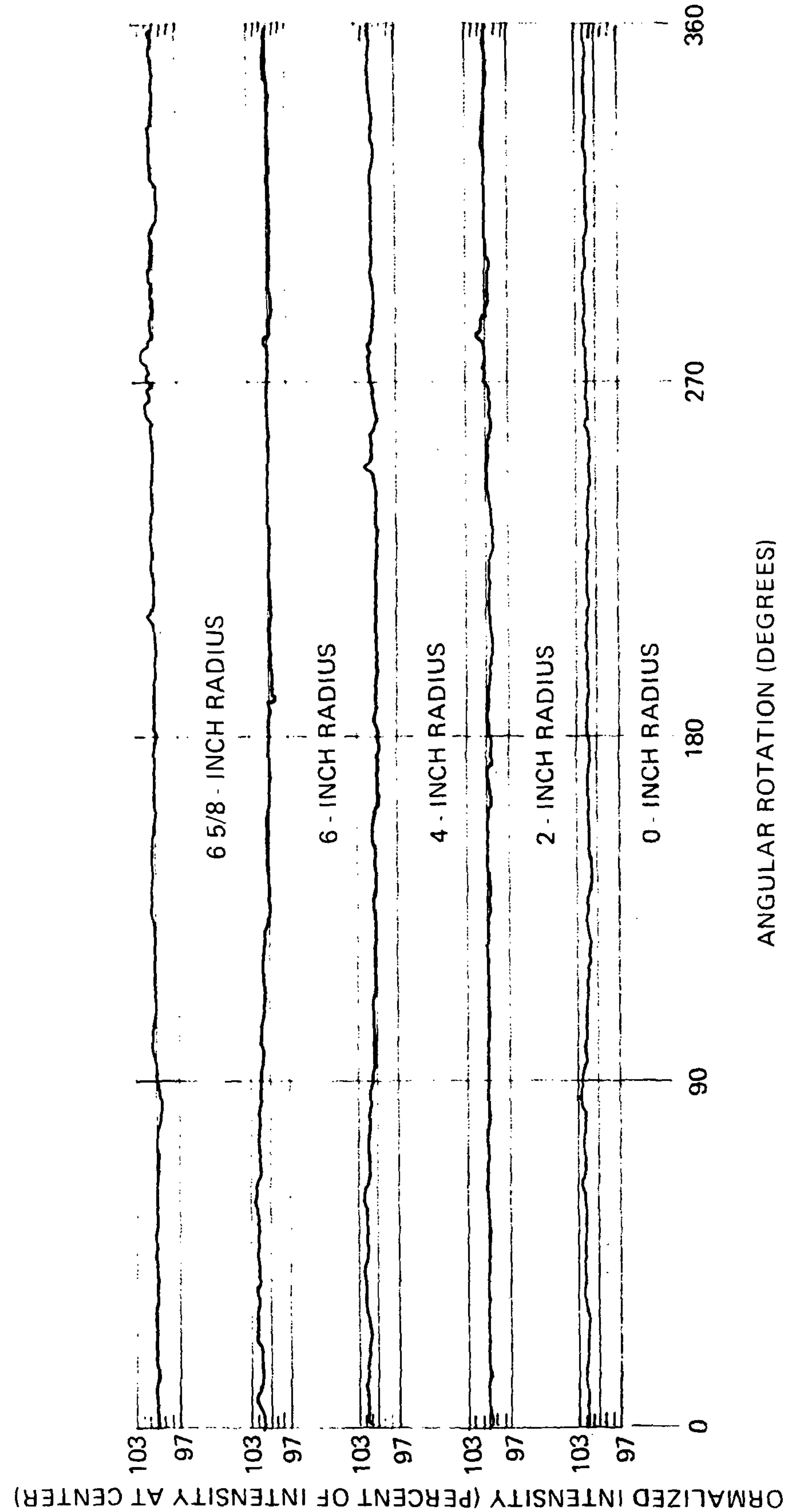

Figure 9 : SOLAR SIMULATOR UNIFORMITY SCANS FOR X-25L MARK II

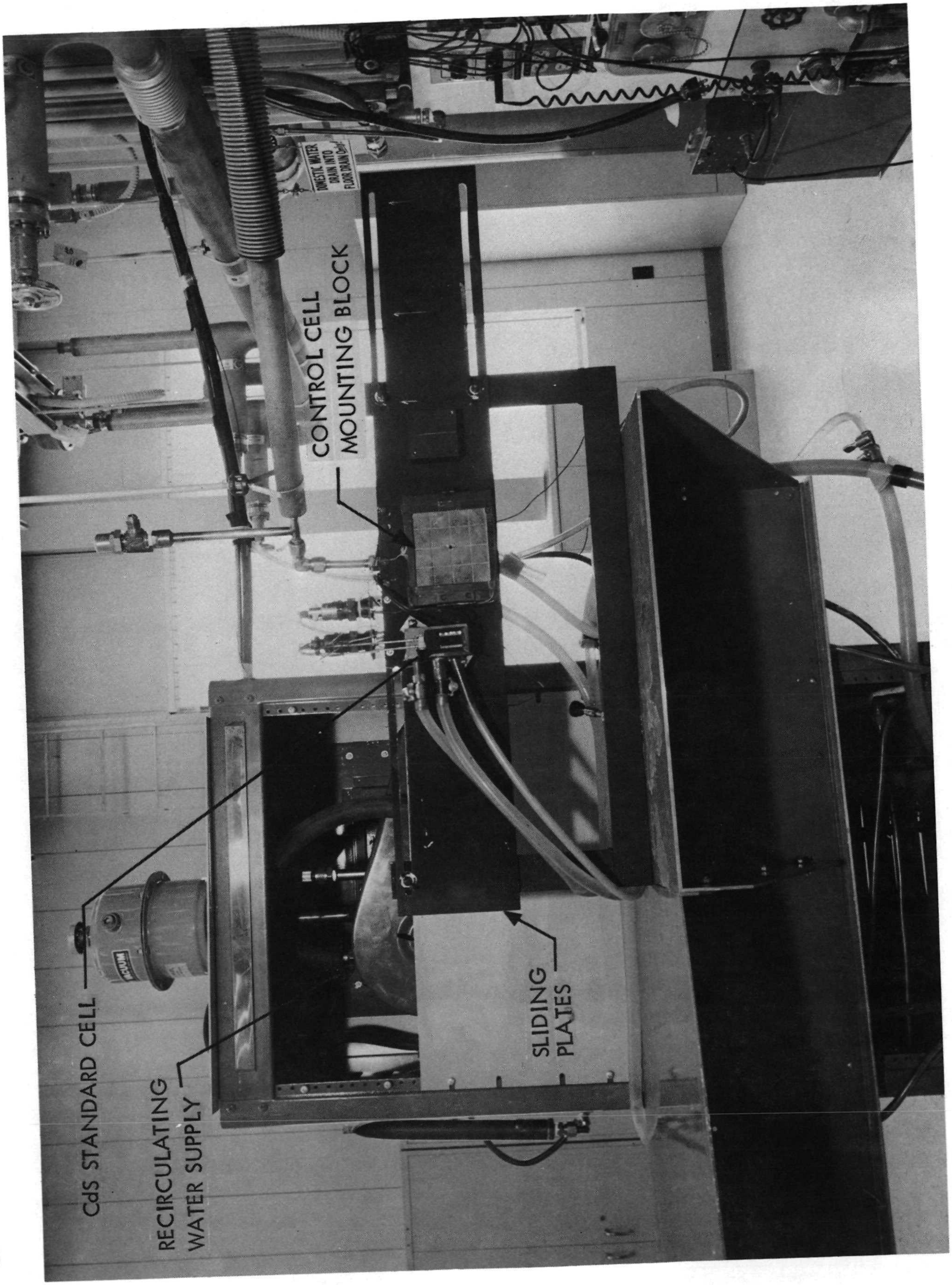

Figure 10: CONTROL-CELL MOUNTING BLOCK,

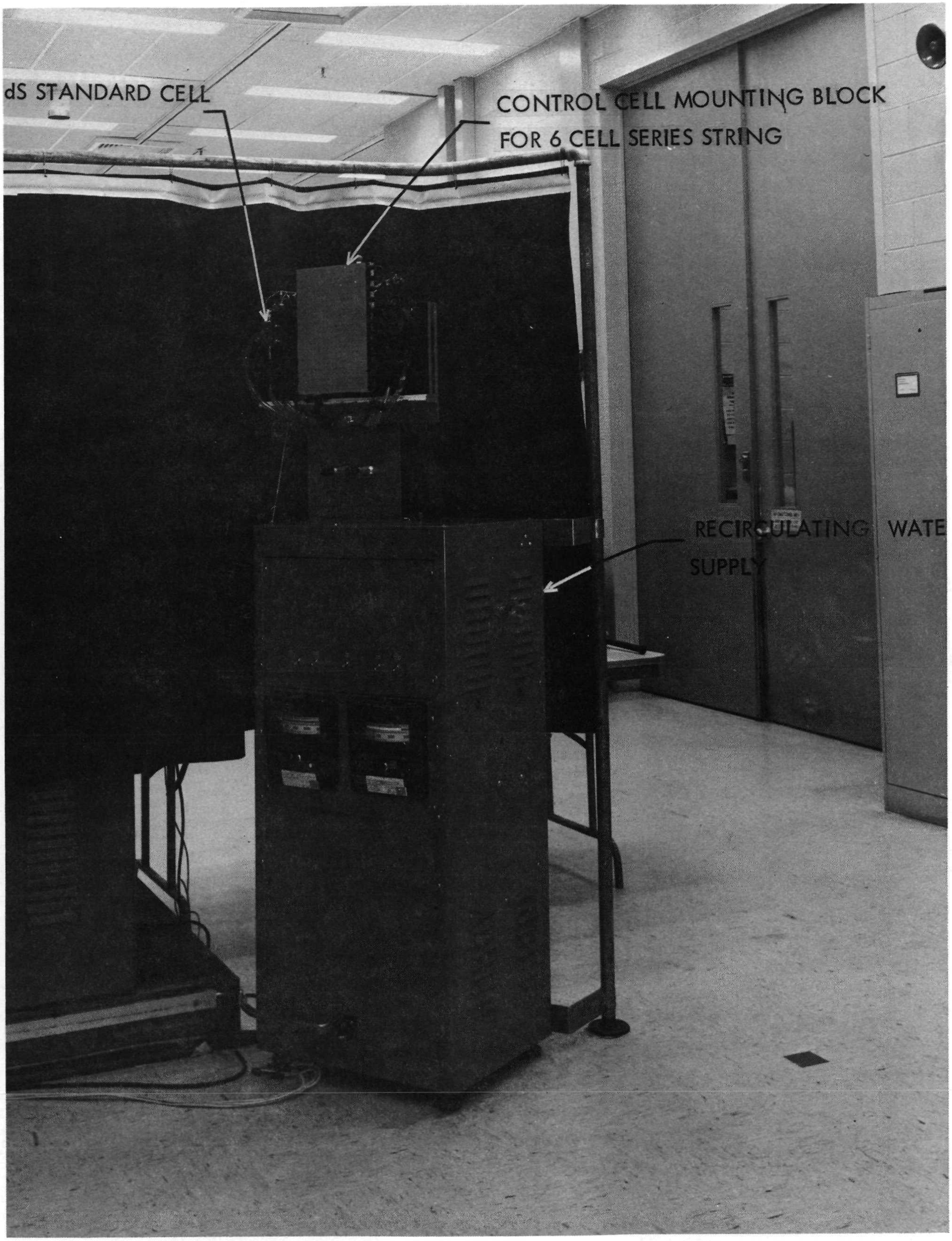

Figure 11: SERIES-STRING CONTROL-CELL MOUNTING BLOCK,

3.2 Data Acquisition

Data are acquired from instruments measuring (1) electrical performance of the CdS solar cells, (2) temperature of the CdS solar cells, and (3) intensity, uniformity, and spectrum of the light source.

3.2.1 CdS Solar Cell Performance Measurement

Current-voltage curves were plotted only during the Group A cell cycle testing, and the precycling tests of the Group B, Group C, Group D, Group E, and Group F cells. Fixed loads were connected to the Group B, Group C, Group D, Group E and Group F cells and the cells' current and output power were determined from measurements of cell voltage. The instrumentation used in recording current-voltage (I-V) curves of the Group A test cells and Group A control cells were: (1) a digital voltmeter, (2) an XY recorder, (3) a precision resistor, and (4) an electronic load. Electrical contact to the cell electrodes is made with a pair of current-carrying leads and a pair of voltage-sensing leads. Thus, four copper wires were soldered to the electrodes of each test cell.

In making I-V curves, the voltage-sensing leads were connected to the X-axis amplifier of the XY plotter. The cell current was carried by two elements in series; a precision one-ohm resistor and an electronic load. The voltage drop across the one-ohm resistor and an electronic load. The voltage drop across the one-ohm resistor, representing the current flowing in the cell, was fed into the Y-axis amplifier of the XY plotter. The amplifiers in the X and Y axes of the plotter were adjusted to make the plotted coordinates correspond to the readings of a digital voltmeter. An electronic load, Spectrolab Model D-550, was operated in a manual mode to vary the load current in the cell being performance tested.

The digital voltmeter accuracy of ±0.1 percent was verified by periodic calibration against a secondary standard whose accuracy is traceable to the National Bureau of Standards (NBS). The accuracy with which the XY plotter recorded the current and voltage was limited by its repeatability and the precision with which each axis could be calibrated against the digital voltmeter. The accuracy of the XY plotter is estimated on this basis to be ±0.5 percent. The one-ohm resistor was accurate to ±0.1 percent.

A load resistor was connected to the current leads of the Group A test cells during the periods between performance measurements. These load resistors were adjusted to make the cells operate near their initial maximum power points. The Group B, Group C, Group D, Group E and Group F cells had similarly adjusted load resistors connected to them at all times while the cells were in the vacuum chambers. The initial maximum-power load resistance was not changed as cells degraded.

3.2.2 CdS Solar Cell Temperature Measurement

Chromel-constantan thermocouples were used to sense cell temperatures. On Group E cell No. 64 there was an additional thermocouple made from chromel-constantan AWG 36 wire. The thermocouple wires were AWG 30, suitably insulated

to prevent shorting. Dow Corning No. 340 heat sink compound was used between the thermocouple and the cell to establish thermal contact. The coated thermocouple was taped to the back of the cell with a one-half-inch square (1.3 cm square) piece of 3M No. 425 aluminum tape. A narrow bead of NARMCO 7343 polyurethane low-temperature adhesive was applied along the four edges of the aluminum tape, to keep the tape from peeling. The tape was then painted with a black paint whose emittance approximated that of the cell back.

A thermocouple was soldered to the back of each silicon reference cell and thermocouples were bonded to the front and back of the test cell supporting frame as well as to the end plate of the cold shroud in the vacuum chamber. Chromel-constantan feed-through connectors were used to route the thermocouple leads out of the vacuum chamber. The temperature of the control-cell mounting block was measured with a thermocouple imbedded in the side of the block.

All thermocouples were connected to a temperature recorder which printed the output of each thermocouple once every 2-1/2 minutes. The recorder could also display continuously the output of any one thermocouple. A reference junction compensator in the recorder facilitated display of the thermocouple outputs directly in °C.

Temperatures between -150°C (123°K) and +100°C (373°K) could be recorded with an accuracy of ± 2°C (2°K) and a reproducibility of ± 1°C (1°K). The temperature recorder was periodically calibrated against a secondary standard whose accuracy is traceable to the NBS.

3.2.3 Solar Simulator Light-Intensity Measurement

The true intensity of the light beam in the test plane was measured with a radiometer whose response to radiation is essentially independent of wave length. Its range of response was 0.25 μ to 2.7 μ. Its accuracy in sunlight is ± 3.0 percent. The radiometer was periodically checked against a secondary standard radiometer which had been calibrated at Table Mountain, California.

Prior to taking a performance measurement the solar simulator intensity was set to AMO with the CdS standard cell.

3.2.4 Solar Simulator Light-Spectrum Measurement

Because the spectrum of the solar simulator was not identical to that of space sunlight, the true intensity measured with the radiometer was slightly different from the equivalent space sunlight (AMO) intensity measured with the CdS standard cell.

The relative spectrum of the light beam was determined with a Beckman Model W139323 Linear prism-type spectroradiometer which recorded the relative energy contained within each 0.05 μ bandwidth, scanning the wavelength region

0.25μ to 2.5μ. The accuracy of the relative energy recorded by the spectroradiometer was ± 8 percent in the ultraviolet region and ±3 percent in the visible and the infrared regions. The spectroradiometer was calibrated periodically with an NBS 1000-Watt standard of irradiance and a magnesium diffusing block.

3.2.5 Solar Simulator Light-Uniformity Measurement

The uniformity of the light beam at the test plane was determined by recording the short-circuit current of a 2 by 2 cm silicon solar cell mounted on a rotary scanner. The output of this cell was recorded at the center of the beam and then continuously while rotated at radii of 0, 2, 4, 6, and 6 5/8 inches (0, 5.1, 10.2, 15.2, and 16.8 cm) about the center. A typically uniformity scan is shown in Figure 8.

4.0 TEST PROCEDURES

During this test program six groups of cells were tested. Three groups of these cells, Group A, Group B, and Group C, were subjected only to thermal cycling. The fourth group, Group D, was subjected to 227 thermal cycles and after that, at NASA's request, to continuous illumination. Group E and Group F were subjected only to continuous illumination. The changeover to continuous illumination required only: (1) leaving the shutter open; and (2) adjusting the cell heaters so that the cell equilibrium temperature was +55°C (328°K).

The cell testing dates are shown as follows:

Cells	Dates	Chamber No.
A + B	Mar. 69 - Sept. 69	4
B + C	Sept. 69 - Feb. 71	4
D	Apr. 70 - Feb. 71	2
E	Mar. 71 - July 71	2
F	Mar. 71 - July 71	4

Two test setups were used, each consisting of a vacuum chamber, solar simulator, and the supporting equipment described in Section 3. The first setup, completed in March, 1969, was used to test the Group A, Group B, and Group C CdS solar cells. The Group A cells were tested for 2124 thermal cycles; Group B cells, placed in the chamber at the same time as the Group A cells, were tested for 10,050 thermal cycles. The Group C cells, which replaced the Group A cells, were tested for 7926 thermal cycles. The Group D cells were tested in the second setup which was completed in April, 1970, and were tested for 227 thermal cycles plus 6321 hours of continuous illumination. The Group E cells were tested for 2646 and the Group F cells were tested for 2639 hours of continuous illumination.

Each test chamber kept nine CdS solar cells at a pressure less than 10^{-6} torr. Thermal cycling was produced by exposing the cells to 30 minutes of darkness followed by 60 minutes of illumination; the cell temperatures dropped to -120°C (153°K) during the dark portion of each cycle. The only time the cycling or continuous illumination was interrupted was when the solar simulator was adjusted for intensity prior to performance measurements, and when maintenance of the solar simulator was required. Cells were maintained at equilibrium temperature when illuminated by adjusting heater power. The heaters were turned off whenever illumination was off. At the start of testing each cell was loaded at its initial maximum power point which was not changed during the test.

A performance measurement of Group A cells consisted primarily of plotting the current-voltage (I-V) curve of the cells under known conditions of light intensity and temperature. Measurement of load voltage was substituted for I-V curve plotting as a performance test for Group B, Group C, Group D, Group E and Group F cells. In all tests the electrical performance of the test cells and control cells (except the 6-cell series control string and the Group E and Group F control cells) was measured at least once every 100 cycles (150 hours). During the first 300 cycles (450 hours) of each test, the performance of the test cells was measured more often: once every ten cycles (15 hours) for the first 100 cycles (150 hours), and once every 30 cycles (45 hours) for the next 200 cycles (300 hours). In addition to the perform-

mance measurements made during testing, performance measurements were also made before and after cycling - some in situ and others not.

4.1 Startup of Cycling

After the test-cell supporting frame containing the test cells was installed in the chamber, a mechanical roughing pump was used to evacuate the chamber to 10^{-4} torr, usually within two hours. Then the ion pump was turned on to reduce the chamber pressure to 10^{-6} torr, usually within several hours. Then liquid nitrogen was fed to the cold shroud, reducing the pressure to 10^{-7} torr within a few minutes. Thirty minutes after the admission of liquid nitrogen, the shutter was opened to allow the solar simulator to illuminate the test cells. The admission of the liquid nitrogen and the opening of the shutter are considered the beginnings of the dark and light portions, respectively, of the first cycle.

4.2 Suspension of Cycling

Whenever cycling had to be suspended because of lamp failures or other causes, the shutter was first closed and then the liquid nitrogen was blown out of the shroud with forced air. As the shroud warmed to room temperature, molecules once trapped on the cold shroud were released, increasing the chamber pressure from 10^{-8} to 10^{-6} torr. Startup of cycling after a shutdown followed the previously described procedure.

Cycling was also suspended for periods of less than five hours when the solar simulator required brief maintenance; for example; replacement of a lamp. In these cases the shutter was closed; but liquid nitrogen was not blown from the shroud.

4.3 Measurement of Test-Cell Performance

Measurement of the Group A test-cell performance was started at the end of the illuminated portion of a cycle to ensure that the cells were near thermal equilibrium performance measurements and took about thirty minutes to complete, thus requiring a 30-minute extension of the illuminated portion of that cycle. Since only load voltage was measured on the Group B and Group C cells, performance measurements on these cells were completed in the last 15 minutes of the illuminated portion of a cycle.

The first step in a performance test of Group A cells was to adjust the light intensity in the center of the beam at the test plane to be equivalent to space sunlight having an intensity of AMO, as indicated by the CdS standard cell. The load resistor of the first Group A cell was then disconnected and the voltage and current leads of that cell were switched into the I-V curve plotting circuit in its open-circuited condition. Calibration of both axes of the XY plotter against the digital voltmeter at two points on the I-V curve then followed. The output of the two reference silicon cells was recorded and then the I-V curve of the first cell was traced from open circuit to short circuit, and back again. Immediately upon completing the I-V trace, the operator recorded the output of the two reference cells and the test-cell temperature, and then replaced the load resistor. The intensity of the lamp did not change during the performance measurement as measured by the silicon reference cell.

This procedure was repeated for the remaining four Group A cells, except calibration of the XY recorder was not repeated. After completing all five I-V traces, the operator recorded the load voltage of each cell to ensure that its load resistor was reconnected. He then recorded the tempera-

tures of the silicon reference cells and the test-cell supporting frame. Upon completion of the performance test, the shutter was closed, the solar simulator was rotated to center the light beam on the CdS standard cell, and the simulator output was again measured.

A performance test of the Group B and Group C test cells consisted of a measurement of load voltage at the cell, rather than drawing an I-V curve. From the load voltage (V_L) and from the load resistor, the load current (I_L) and load power (P_L) were calculated. Load voltage was measured with a digital voltmeter.

For the Group D test cells, the voltage across the series string-load resistor and the voltage across each individual cell in the string, were measured with a digital voltmeter. Also, the voltages across the load resistors of the three individual cells were recorded. From the load voltage (V_L), the load current (I_L), and load power (P_L) were calculated.

For the Group E and Group F test cells, the load voltage at the cell and the voltage across the load resistor was measured. From these measurements, the load current (I_L) was determined and the load power (P_L) was calculated.

4.4 Measurement of Control-Cell Performance

Measurements of control-cell performance, obtained within one cycle of the test cell data and during the dark portion of a cycle, took about thirty minutes to complete. The first step in this performance test was to adjust the equivalent intensity in the center of the beam at the test plane outside of the chamber to correspond to space sunlight intensity of AMO, as indicated by the CdS standard cell. The first Group A control cell was then placed on the control-cell mounting block, whose temperature had previously been adjusted to +25°C (298°K). The block was slid to the center of the beam and the I-V curve of the cell was traced from open circuit to short circuit, and back again. Immediately after the I-V curve was traced, the block temperature was recorded, the CdS standard cell was again placed in the center of the beam, and its output was recorded. This procedure was repeated for the remaining four Group A control cells.

With the Group B and Group C control cells, the voltage output across a fixed load resistor on the cells was measured with a digital voltmeter. No I-V curve was traced. From the load voltage (V_L) measurements, the load current (I_L) and load power (P_L) were calculated.

With the Group D control cells, the voltage across the series-string load resistor and the voltage across each individual cell in the string was measured. Performance of the Group D series string control cells was measured only when Test II was interrupted for refurbishment of the X-25L Mark II solar simulator. This limitation came about because the large control-cell fixture for the six series string cell group was arranged for illumination only by the X-25L Mark II simulator that was being used to continuously illuminate Group D test cells. Performance of the Group D individual control cells was measured whenever the performance of the Group B and Group C control cells was measured.

The Group E and F control cells could only be measured when the continuous illumination was interrupted for solar simulator refurbishment. Measurements of the control cells were made with the X-25L Mark II solar simulator.

4.5 Determination of Light Absorption in Quartz Window

The light intensity in the vacuum chamber could not be measured directly with the CdS standard cell during thermal cycling or continuous-illumination testing. Therefore, before the chamber was closed at the beginning of each test, the loss in intensity due to the light passing through the quartz window was determined. The loss in intensity was six percent. This was done by measuring the output of the CdS standard cell while located outside the vacuum chamber after the intensity had already been increased so that the equivalent space sunlight intensity at the test-plane inside the vacuum chamber was at AMO as measured by the CdS standard cell placed in the chamber. Measurements made with a CdS standard cell, in Contract NAS3-6008 before and after tests, showed that the transmission of the quartz window did not change by more than one percent (Reference 4).

4.6 Adjustment of Light Intensity

Equivalent space sunlight intensity of the illumination at the control-cell block was easily obtained by directly monitoring the output of the CdS standard cell.

Adjustment of the intensity for the test plane in the vacuum chamber was done during the dark cycle preceeding the light cycle in which the performance of the test cells was to be measured. The solar simulator was rotated, the output of the CdS standard cell at the center of the beam was measured, and the intensity of the solar simulator was adjusted to make the CdS standard cell reading correspond to AMO plus the transmission losses through the quartz window.

4.7 Measurement of Light Uniformity

The uniformity of the light beam from the solar simulator was measured at 500 hours of lamp life, and every 150 hours thereafter, whenever the lamp or simulator optics was changed, and at the beginning and end of the test. The procedure used is described in Section 3.2.5.

4.8 Measurement of Light Spectrum

The spectrum of the solar simulator was measured whenever the lamp or optics was changed, at 500 hours of lamp life and every 150 hours thereafter, and at the beginning and end of each test. This was done by rotating the solar simulator away from the vacuum chamber and centering the beam on the entrance slit of the spectroradiometer described in Section 3.2.4. The equivalent space sunlight intensity at the entrance slit was adjusted to AMO as indicated by the CdS standard cell. The true intensity at the entrance slit was then measured with the radiometer. The wavelength region between 0.25 and 2.5 microns was scanned and plotted automatically by the spectroradiometer. This plot represented

the relative spectrum of the light beam. A typical reading at AMO for the radiometer (Serial Number 257) was 9.84 millivolts.

The area under the curve produced by the spectroradiometer was then integrated in each of the 14 wavelength bands of interest. These areas were converted to true intensities by normalizing the total area under the curve to the total intensity as measured by the radiometer. The resulting intensities represent the absolute spectrum of the solar simulator outside the test chamber. The absolute spectrum at the test-cell plane inside the vacuum chamber was calculated by modifying the outside spectrum by (1) multiplying all the values by the ratio of the CdS standard cell setting used during test-cell performance measurements to the setting used during control-cell performance measurements, and (2) reducing all the spectrum values by the corresponding absorptions in the quartz window.

4.9 Monitoring of Test Environment

During thermal cycling, the chamber pressure, the light intensity, and the test-cell temperatures were periodically monitored between performance tests to ensure that the cells were being exposed to the desired space environment. The chamber pressure and the light intensity were read and recorded by laboratory personnel two or three times during each laboratory shift. Furthermore, an alarm would sound if the vacuum were lost, if the illumination were lost, or if the shutter opened or closed improperly. The temperatures of the test-cells, the supporting frame, and the silicon reference cells were recorded every 2-1/2 minutes during a complete thermal cycle at least once during each 8-hour shift. A plot of CdS cell temperature for a typical cycle is shown in Figure 12.

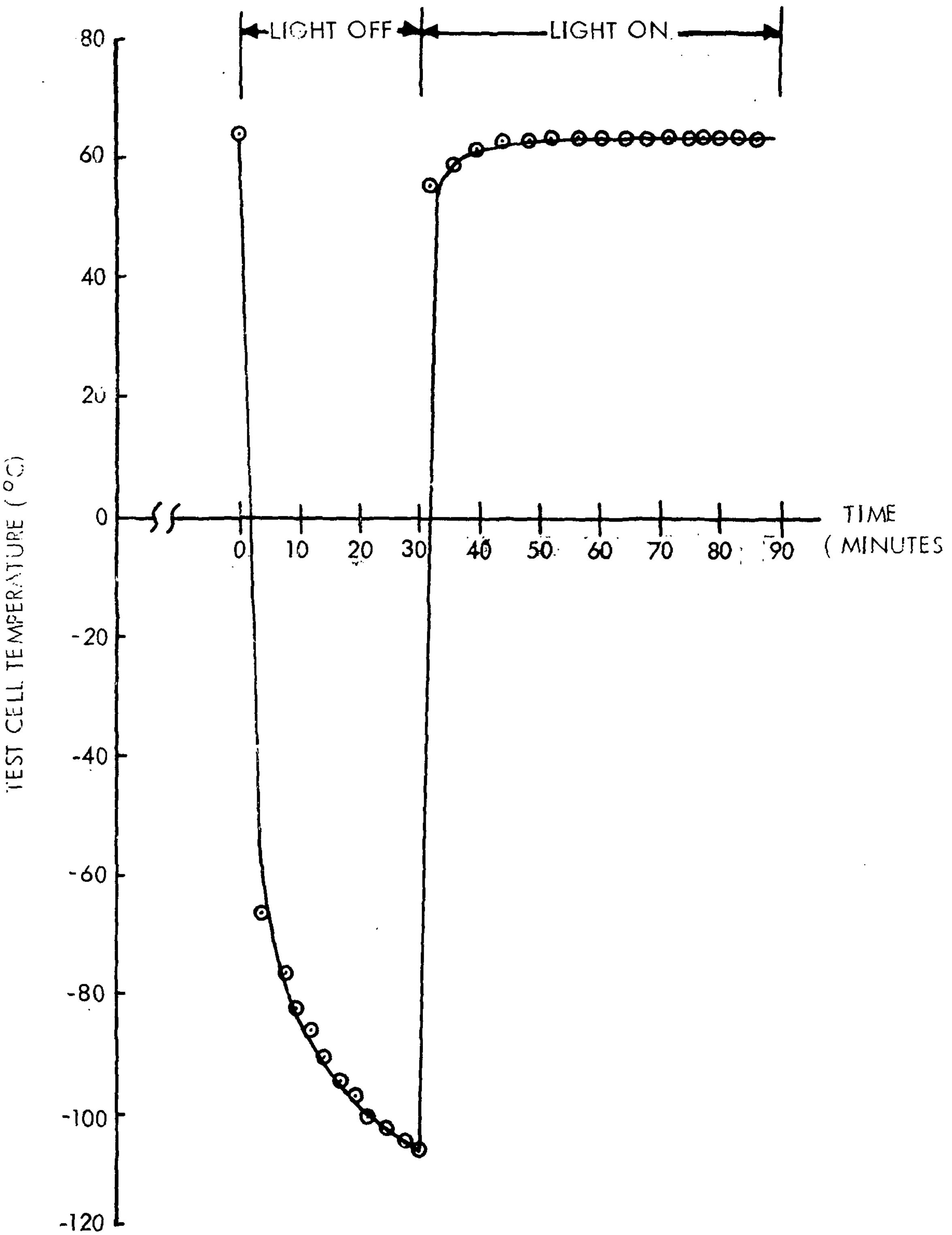

Figure 12: TEST-CELL TEMPERATURE DURING A THERMAL CYCLE

5.0 DISCUSSION AND RESULTS

The objective of this testing was to determine how the power output of CdS solar cells is affected by prolonged exposure to a simulated space environment, including thermal cycling.

This section will describe the cell wiring, data correction, an anomaly associated with poor thermocouple attachment, and a cell holder failure. The data obtained, summarized in curves and tables, are presented.

5.1 Cell Wiring

The Group A, Group B, Group C, Group E and Group F test cells were wired to the instrumentation as shown in Figure 13. The wire resistance between the cell and potentiometer is lumped as lead resistance (R_ℓ). This lead resistance plus the potentiometer resistance constitute the load resistance across the cell. A separate pair of voltage-sensing wires connected to the cell facilitates measurement of the load voltage of the cell. From the load voltages and load resistances,the Group B and Group C cell currents and powers were calculated. For the Group E and Group F cells, the current through the potentiometer resistance was measured and the power was calculated by multiplying the voltage times the current.

The four leads were used in conjunction with a load bank and XY plotter in drawing performance (I-V) curves of the Group A cells.

The individual Group D cells require only two wires because no performance (I-V) curves were required. The lead resistance plus the potentiometer resistance constitute the load resistance across the cell (Figure 14). The load voltage (V_L) of the cell is calculated from the measured voltage (V_p), as follows:

$$V_L = V_p\left(\frac{R_\ell}{R_p} + 1\right)$$

where R_ℓ is the lead resistance and R_p is the potentiometer resistance.

The load voltage of the test cells in the series string is read directly as shown in Figure 14.

5.2 Data Correction

Prior to and following solar-vacuum testing, the test cells and control cells were subjected to precycling tests where their temperature coefficients of load power, load voltage and open-circuit voltage were measured. These temperature coefficients were used later in correcting the cell performance measured during space environment testing to a standard temperature of 60°C (333°K) for the Group A, Group B and Group C test cells, and to 55°C (328°K) for the Group D, Group E and Group F test cells. All control cells were corrected to a temperature of 25°C (298°K). This data are shown in Section 8. Tables A-3 through A-34.

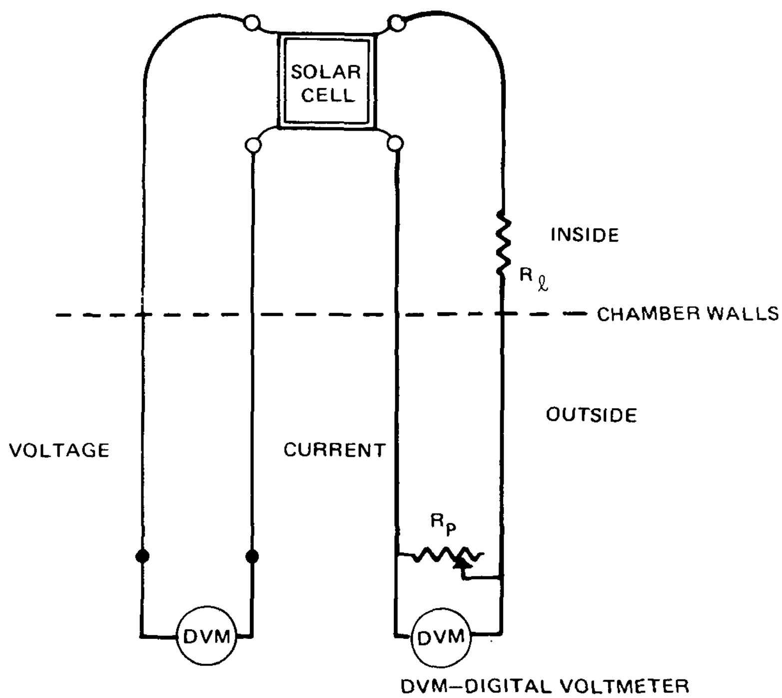

Figure 13: WIRING OF GROUP A, GROUP B, GROUP C, GROUP E, AND GROUP F CELLS

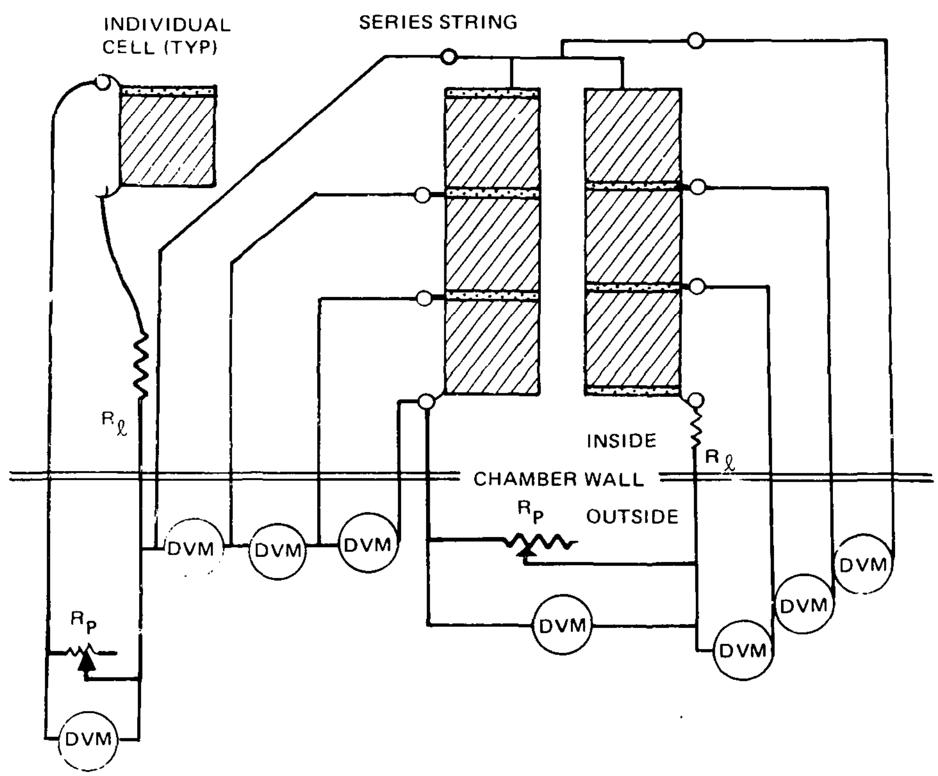

Figure 14: WIRING OF GROUP-D TEST CELLS

The sequence of precycling and postcycling measurements was as follows. The temperature of the test cell block was set at 60°C (333°K), except for the Group E and Group F cells where the temperature was set at 55°C (328°K). The test cells were mounted, one at a time, on the block and performance (I-V) curves were recorded at a light intensity of one solar constant as shown by the CdS standard cell. After all cells were tested, this procedure was repeated at block temperatures of 45°C (318°K), 35°C (308°K) and 25°C (298°K) for the Group A cells only. For the other Groups, a load resistor, equal to the load at maximum power, was placed across the cell and the load voltage was measured as the temperature was reduced. These data are shown in Section 8, Tables A-3 through A-34.

This same procedure was used in measuring the temperature coefficients of the control cells.

5.3 Thermocouple Attachment

Thermocouples were attached to the Group A, Group B, Group D, Group E and Group F solar cells as described in Section 3.2.2. When the Group A cells were replaced with Group C cells, NASA suggested attaching thermocouples with masking tape because of good experience with this method. A roll of masking tape sent to Boeing with the Group C cells was used to attach the thermocouples to the backs of the cells.

Within 200 cycles the average temperature of the Group C test cells was noticeably lower than the average temperature of the Group B test cells. The Group C cell data, when corrected to 60°C (333°K) using the coefficients in Section 8.0, Table A-33, indicated serious cell degradation. However, there was no reason to expect the Group C cells to suddenly start operating at a lower temperature than the Group B cells. If we assumed that the Group C cells were operating at the same temperature as the Group B cells, and corrected the data accordingly, then the Group C test-cell degradation became comparable to the Group B test-cell degradation.

On July 23, 1970, vacuum chamber number 4 was opened and the thermocouple attachment was inspected by NASA and Boeing personnel. The masking tape had formed a "tent" cover over the Group C solar cell thermocouples. This was in contrast to the tight cover which takes the shape of the thermocouple, as observed on the Group B solar-cell thermocouples which had been attached with the aluminum tape and epoxy polyurethane. It was not possible to tell if the thermocouples held with masking tape were firmly against the solar cells.

The masking tape and thermocouples were removed from four of the five Group C solar cells. A masking-tape bonded thermocouple was left on Group C Cell 20 as a control. The four thermocouples, when checked in ice water and in boiling water, were found to be accurate to ±1°C (1°K). New thermocouple beads were formed because the old beads were coated with fragments of the old heat sink compound. In an ice water and boiling water check, the new thermocouples were found to be accurate to ±1°C (1°K).

Dow Corning No. 340 heat sink compound was placed on the thermocouple which was then pressed firmly into place on the back of the solar cell with a piece of aluminum tape (3M No. 425) about one-half-inch square (1.3 cm square). The form of the thermocouple could be seen through the tape. A narrow bead of NARMCO 7343 polyurethane low-temperature adhesive was applied along the four edges of the aluminum tape to keep the tape from peeling. The tape was painted black.

The solar cells were reinstalled in the vacuum chamber. After the first thermal cycle the average temperatures of the Group C cells with this aluminum tape holding the thermocouples was within 2°C (2°K) of the average temperature of the Group B test cells. The masking-tape-held thermocouple on Group C Cell 20 indicated 12°C (12°K) colder, the temperature of all the Group C solar cells prior to the change in the thermocouple attachment. NASA Lewis subsequently established that the masking tape furnished to Boeing with the Group C cells differed from the tape that had been previously found to be successful.

5.4 Cell Holder Failure

Sometime between thermal cycle 918 and 1044 one end of a bar on the fiberglass frame fell down in front of cells number 7, 8, and 9. The bar partially covered the three cells and caused these cells to perform poorly from cycle 1044 to cycle 1504. After cycle 1504 the chamber was opened and the bar was secured to its proper place on the frame. The test data was corrected to show the performance of the cells as it should have been if the cells had not been shaded. The area correction for the shading did not return the cells to their performance as it was before and after shading. The reason the area correction did not return the cell power to its pre-shaded and post-shaded values was because of the increase in cell series resistance due to shading. Cells number 7 and 8 were shaded 13 percent and cell number 9 was shaded 8.1 percent. The percent of unshaded area divided into one equals the area correction factor. This value was multiplied by the cell power to correct it for the area shaded.

5.5 Test Results

The results of the thermal cycling tests and the constant illumination tests are shown in Figures 25 through 78 and Tables 9 through 30. All relative values of cell performance parameters, shown in percent, were derived as follows:

Relative Quantity	Symbol	Applicable to Group Cells	Equation
Maximum Power	P'_m	A	$P'_m = \frac{100\ P_m}{P_m(1)}$
Open-Circuit Voltage	V'_{oc}	A	$V'_{oc} = \frac{100\ V_{oc}}{V_{oc}(1)}$
Short-Circuit Current	I'_{sc}	A	$I'_{sc} = \frac{100\ I_{sc}}{I_{sc}(1)}$
Fill Factor	FF'	A	$FF' = \frac{100\ FF}{FF(1)}$

Relative Quantity	Symbol	Applicable to Group Cells	Equation
Load Power	P'_L	B-C-D-E-F	$P'_1 = \frac{100\ P_1}{P_L\ (1)}$
Load Voltage	V'_L	B-C-D-E-F	$V'_1 = \frac{100\ V_1}{V_L\ (1)}$
Load Current	I'_L	B-C-D-E-F	$I'_1 = \frac{100\ I_1}{I_L\ (1)}$

NOTES

- The quantities P_m, V_{oc}, I_{sc}, FF, P_L, V_L, and I_L are the readings, corrected for temperature variations, obtained at the cycle number or elapsed time indicated.
- Quantities (1) are the readings taken at the first cycle or beginning of test, in the chamber, with less than 10^{-6} torr pressure. These values are shown in Tables 9 through 30.

The data for the Group C test cells prior to the thermocouple repair was corrected to +60°C (333°K) on the assumption that the temperature of the Group C test cells was the same as the average temperature of the Group B test cells. After the thermocouple repair, the indicated temperature of the Group C test cells was used in correcting the data to +60°C (333°K). The measurements were also corrected for light intensity, when necessary. The effective intensity for all measurements is at AMO. The equations used in making the corrections are shown in the Appendix (Section 8.0, Table A-1).

5.5.1 Group E and Group F Test

The Group E and Group F test cells were the last cells to be tested and the next paragraphs will describe the thermocouple attachment, solar simulator measurements, and the results of the postcycling tests.

Figure 15 shows the frontside of the Group E test cells at the end of their test. The backside of the cells are shown in Figure 16 . An extra thermocouple of AWG 36 wire was installed on the back of cell number 64, to verify the temperature of the heavier wire thermocouple, AWG 30 wire, in the center of the cell. Figures 17 and 18 show the frontside and the backside of the Group F test cells.

All thermocouples on the Group E and Group F test cells were bonded to the backs of the cells as described in Section 3.2.2. At the beginning of the test, after temperature equilibrium, the thermocouples were read with the

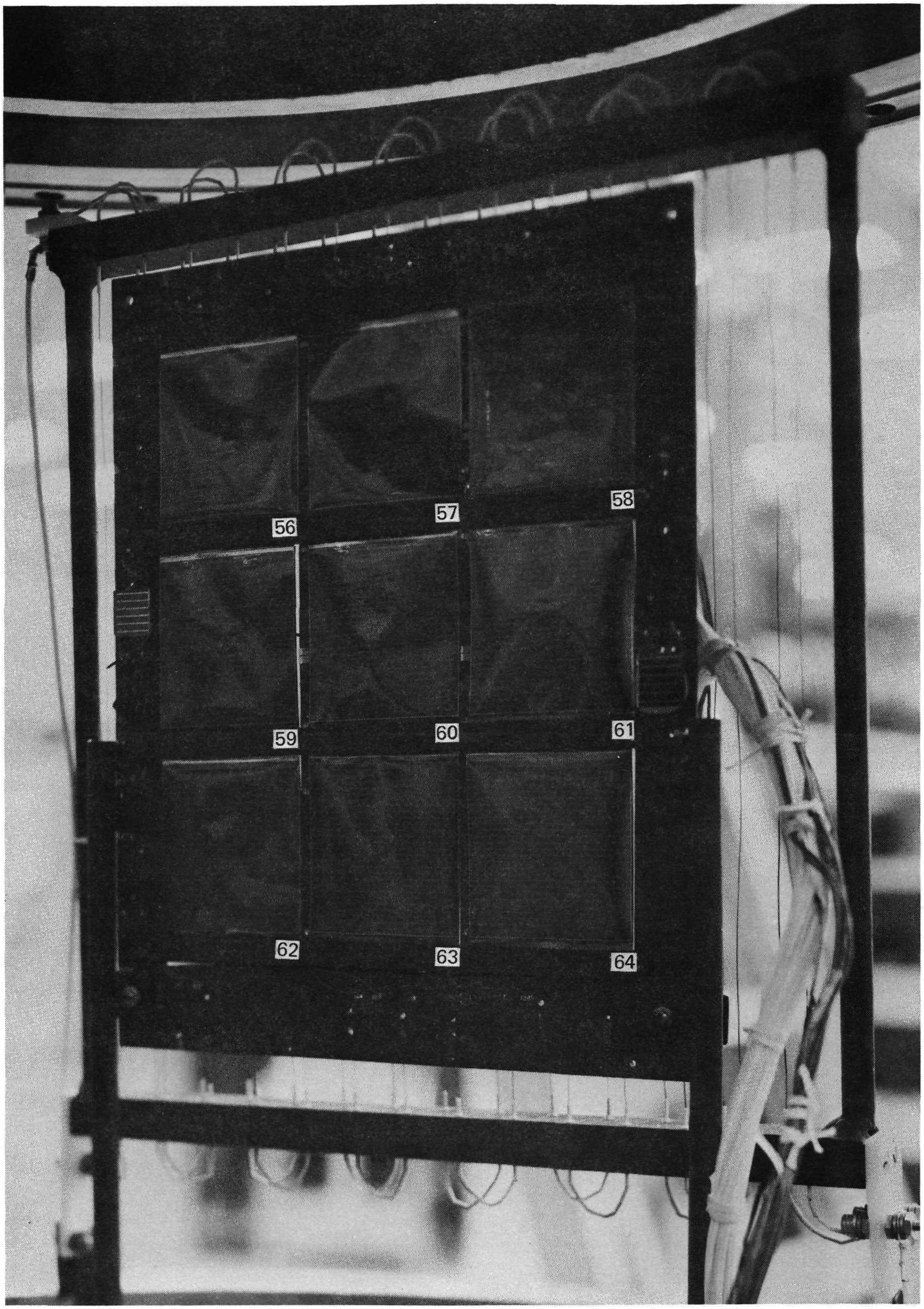

Figure 15 : FRONT SIDE OF THE GROUP E TEST CELLS IN THE VACUUM CHAMBER- BOEING NUMBERS IN THE LOWER RIGHT CORNER - END OF TEST

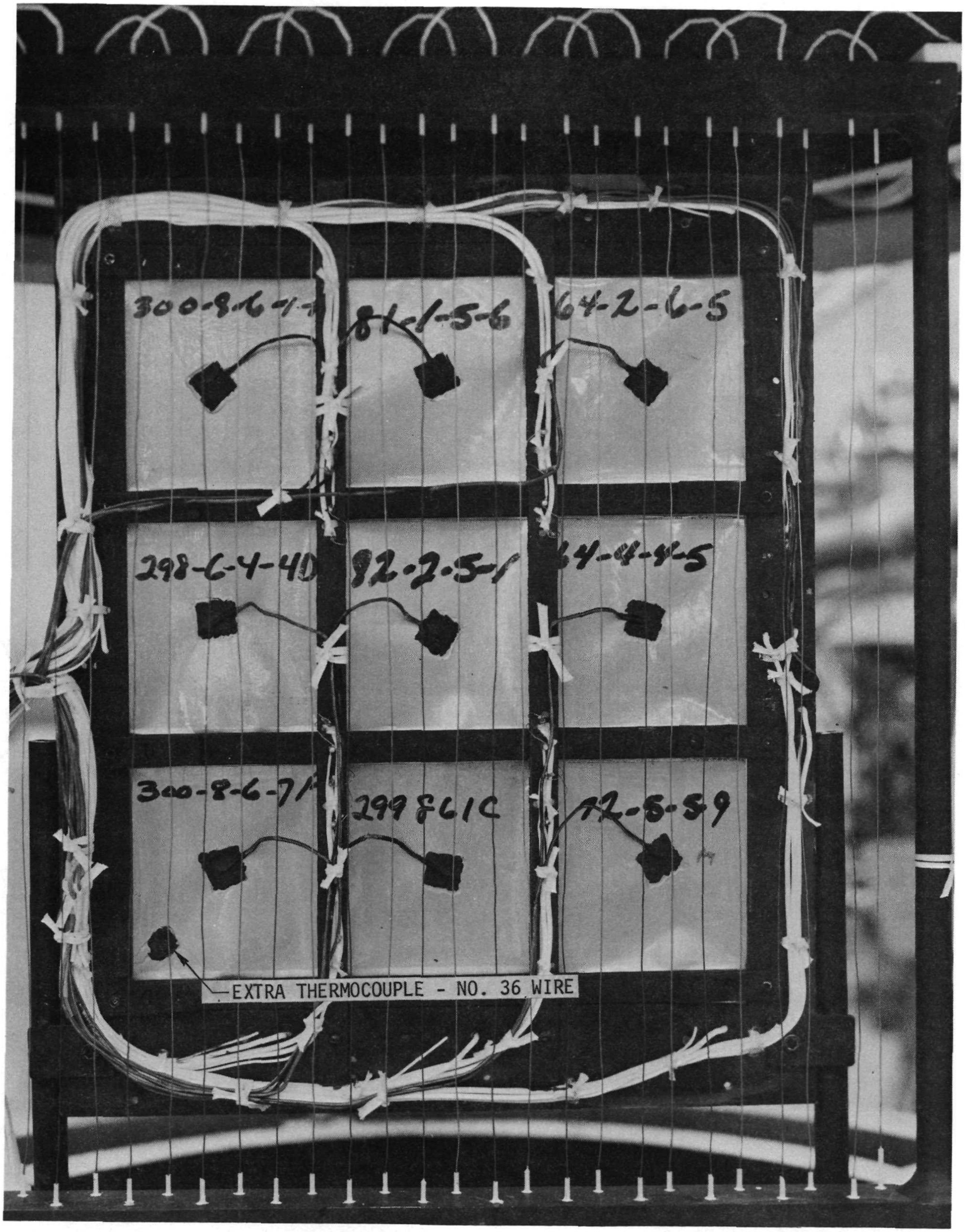

Figure 16: BACK SIDE OF THE GROUP E TEST CELLS AND HEATERS IN THE VACUUM CHAMBER - END OF TEST

Figure 17: FRONT SIDE OF THE GROUP F TEST CELLS IN THE VACUUM CHAMBER - BOEING NUMBERS IN LOWER RIGHT CORNER - END OF TEST

Figure 18 : BACK SIDE OF THE GROUP F TEST CELLS AND HEATERS IN THE VACUUM CHAMBER - END OF TEST

cell heaters off. The average temperature of the Group E cells was 56°C. (329°K) with a 6°C (6°K) spread. At the end of test with the heaters off, the average temperature was 52°C (325°K) with a 3°C (3°K) spread. The Group F cells average temperature under the same conditions as the Group E cells was 51°C (324°K) at the start and 50°C (323°K) at the end of test with a 3°C (3°K) spread between cells in both cases. The narrow temperature spread between cells and the narrow average temperature spread between cells at the beginning and end of the test indicates that the thermocouples were in good contact with the solar cells. In addition, performance curves were drawn for cells number 54 and 64 at the end of test, in-situ, with the heaters off. A comparison of the temperature of the cell as computed from the cells open-circuit voltage with the thermocouples shows a maximum difference of 5°C (5°K) which is 1.5 percent, the minimum difference was 3°C (3°K). During postcycling, a test cell was placed frontside first on the temperature controlled block with the thermocouple left on the cell. With the solar simulator on at an intensity of AMO and with the thermocouple shaded, the cell thermocouple and the temperature controlled block read exactly the same temperature, 55°C (328°K). A typical thermocouple installation is shown in Figure 19.

The conclusion from the preceeding paragraphs is that the method described in Section 3.2.2 for installing thermocouples is a good way to install thermocouples on cadmium sulfide solar cells. Also the temperatures recorded for the Group E and Group F test cells are correct.

After testing but prior to the postcycling tests, uniformity of intensity scans, spectral energy distribution scans, and a verification of the transmission loss through the quartz windows were taken. The uniformity of intensity scans were within ± 2 percent, and the spectral energy distribution scans are shown in Tables 5 through 8. Verification of the transmission loss through the quartz windows showed that when the light intensity of the solar simulators are set with the CdS standard cell no. C-48 at a value of 32.6 mA on the temperature-controlled block, the intensity on the vacuum side of the quartz window as measured with the standard cell is 30.8 mA which is AMO (Reference 8).

During the last hour of simulated space testing, data were taken for all test cells and I-V curves were taken only for test cells number 54 (Group F) and number 64 (Group E) per NASA's instructions. A comparison of the load power as calculated from the data with the in-situ I-V curves shows agreement. The load power point falls on the I-V curve. A comparison of the change in load power throughout the life of the test with the change in maximum power as measured with the I-V curves in-situ show differences of 2.3 to 7.3 percent. This difference is because the load power point degrades along a constant load line whereas the maximum power point changes along a somewhat constant voltage line (there is 2.5 percent increase in current).

A comparison of the I-V curves for cells number 54 and 64 in-situ during the last hour of testing with the I-V curves on the control block during post-cycle testing show that cell number 54 agrees within 1.2 percent whereas cell

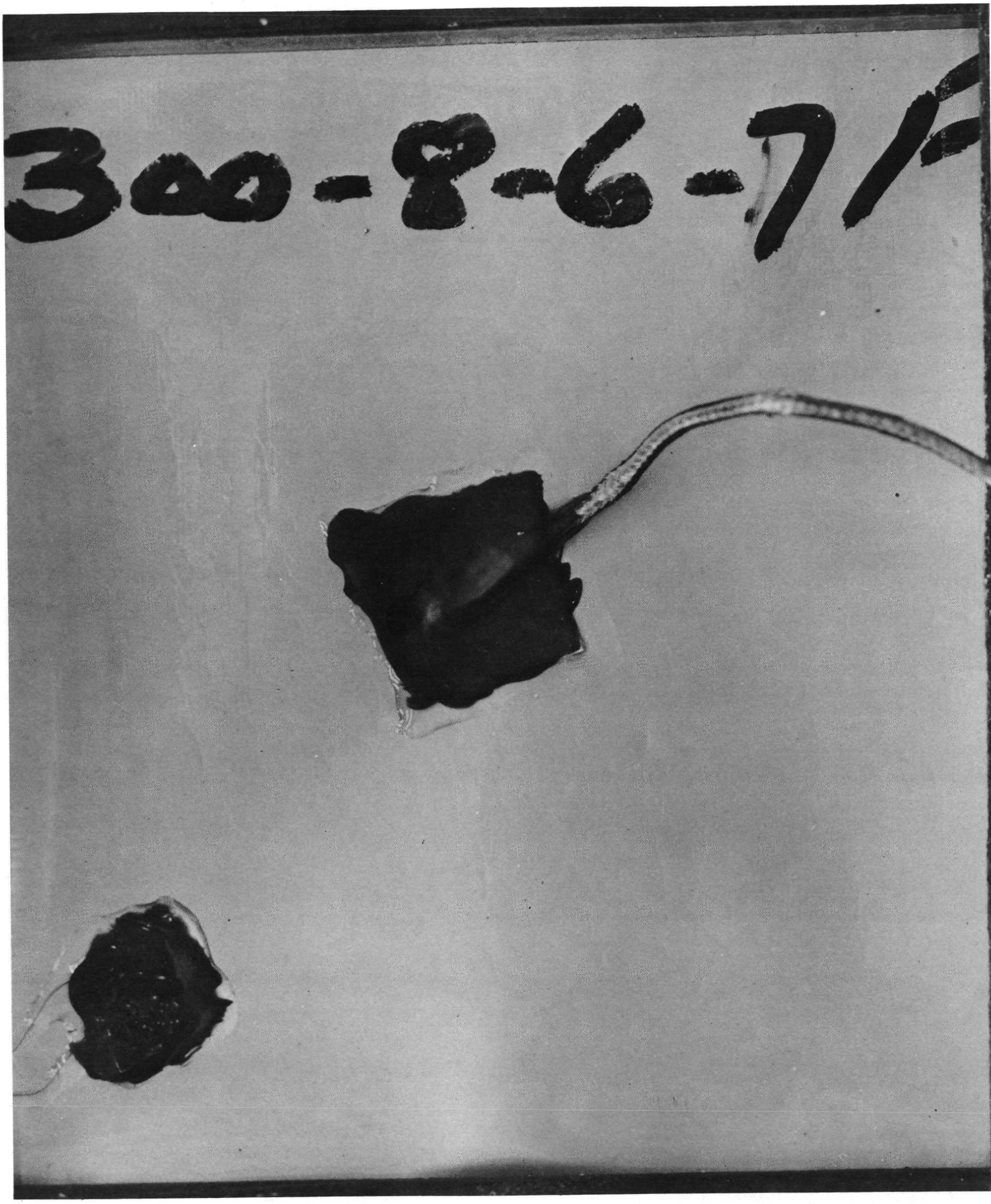

Figure 19 : THERMOCOUPLE INSTALLATION ON THE BACK OF GROUP E TEST CELL NUMBER 64 - END OF TEST

Table 5: SPECTRAL INTENSITY OF SOLAR SIMULATOR

CUSTOMER: NASA Lewis

SOLAR SIMULATOR MODEL NO.: X-25L CH 4

CONFIGURATION: Chamber 4 with UV Vacuum window

DATE OF MEASUREMENT: 7-13-71

BY: Ed Neighbors

COMPUTER OUTPUT NO.:

PROGRAM NAME: Thin Film Solar Cell Test

CdS Cell = 30.8 mv 2,641.3 hrs of continuous solar

DR-2 = 9.06 773.7 hrs on lamp S/N 016943

ETI = 9,448.9

The table below depicts spectral data both relatively and in Watts/meter^2 for the solar simulator. The % deviation with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in Column 6.

Band No.	Bandwidth (in Microns)	Matched Data	Normalized Matched Data W.R.T. One-Solar Constant (w/m^2)	NRL (w/m^2)	% Deviation
1.	0.25 0.35	6.0	28.5	62.82	-54.6
2.	0.35 0.40	11.9	56.5	61.42	- 7.9
3.	0.40 0.45	15.2	72.2	95.90	-24.7
4.	0.45 0.50	18.6	88.4	106.10	-16.7
5.	0.50 0.60	39.3	186.7	191.25	- 2.4
6.	0.60 0.70	36.1	171.5	161.94	+ 5.9
7.	0.70 0.80	26.6	126.4	127.03	- 0.5
8.	0.80 0.90	20.1	95.5	100.52	- 5.0
9.	0.90 1.00	19.2	91.2	80.96	+12.7
10.	1.00 1.20	28.8	136.8	121.46	+12.7
11.	1.20 1.50	28.7	136.4	111.68	+22.1
12.	1.50 1.80	17.2	81.7	61.84	+32.1
13.	1.80 2.20	10.9	51.8	44.25	+17.0
14.	2.20 2.50	4.7	22.3	19.13	+16.7

Table 6: SPECTRAL INTENSITY OF SOLAR SIMULATOR

CUSTOMER: NASA Lewis

SOLAR SIMULATOR MODEL NO.: X-25L

CONFIGURATION: Chamber 4 w/o vacuum window

DATE OF MEASUREMENT: 7-13-71

BY: Ed Neighbors

COMPUTER OUTPUT NO.:

PROGRAM NAME: NASA Lewis Thin Film Solar Cell

CdS Cell = 32.6 mv 2,641.3 hrs of continuous solar

DR-2 = 9.72 773.7 hrs on lamp S/N 016943

ETI = 9,448.9 hrs

The table below depicts spectral data both relatively and in Watts/meter^2 for the solar simulator. The % deviation with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in Column 6.

Band No.	Bandwidth (in microns)	Matched Data	Normalized Matched Data W.R.T. One-Solar Constant (W/m^2)	NRL (W/m^2)	% Deviation
1.	0.25 0.35	6.0	26.8	62.82	-57.4
2.	0.35 0.40	13.1	58.5	61.42	- 4.8
3.	0.40 0.45	15.4	68.8	95.90	-28.3
4.	0.45 0.50	19.9	88.8	106.10	-16.3
5.	0.50 0.60	40.4	180.4	191.25	- 5.7
6.	0.60 0.70	39.0	174.1	161.94	+ 7.5
7.	0.70 0.80	28.4	126.8	127.03	- 0.2
8.	0.80 0.90	21.7	96.9	100.52	- 3.6
9.	0.90 1.00	19.6	87.5	80.96	+ 8.1
10.	1.00 1.20	30.8	137.5	121.46	+13.2
11.	1.20 1.50	31.0	138.4	111.68	+23.9
12.	1.50 1.80	18.2	81.3	61.84	+31.4
13.	1.80 2.20	12.0	53.6	44.25	+21.1
14.	2.20 2.50	6.0	26.8	19.13	+40.0

Table 7: SPECTRAL INTENSITY OF SOLAR SIMULATOR

CUSTOMER: NASA Lewis

SOLAR SIMULATOR MODEL NO. X-25 MK II

CONFIGURATION: Chamber 2 w/window

DATE OF MEASUREMENT: 7-13-71

BY: Ed Neighbors

COMPUTER OUTPUT NO.:

PROGRAM NAME: NASA Lewis CdS Solar Cell Test

CdS Cell = 30.8 mv 2,649.1 hrs of continuous solar

DR-2 = 9.74 hr 342.3 hrs on lamp S/N 016981

ETI = 9,474.5 hrs

The table below depicts spectral data both relatively and in Watts/meter^2 for the solar simulator. The % deviation with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in Column 6.

Band No.	Bandwidth (in Microns)	Matched Data	Normalized Matched Data W.R.T. One-Solar Constant (w/m^2)	NRL (w/m^2)	% Deviation
1.	0.25 0.35	6.0	30.7	62.82	-51.1
2.	0.35 0.40	11.6	59.4	61.42	- 3.3
3.	0.40 0.45	14.5	74.3	95.90	-22.6
4.	0.45 0.50	17.6	90.1	106.10	-15.1
5.	0.50 0.60	35.2	180.3	191.25	- 5.7
6.	0.60 0.70	33.7	172.6	161.94	+ 6.6
7.	0.70 0.80	25.5	130.6	127.03	+ 2.8
8.	0.80 0.90	20.0	102.4	100.52	+ 1.9
9.	0.90 1.00	18.3	93.7	80.96	+15.8
10.	1.00 1.20	26.2	134.2	121.46	+10.5
11.	1.20 1.50	25.7	131.6	111.68	+17.9
12.	1.50 1.80	14.6	74.8	61.84	+20.9
13.	1.80 2.20	9.6	49.2	44.25	+11.1
14.	2.20 2.50	4.3	22.0	19.13	+15.1

Table 8: SPECTRAL INTENSITY OF SOLAR SIMULATOR

CUSTOMER: NASA Lewis

SOLAR SIMULATOR MODEL NO. X-25 MK II

CONFIGURATION: Chamber II (without window)

DATE OF MEASUREMENT: 7-13-71

BY: Ed Neighbors

COMPUTER OUTPUT NO.

PROGRAM NAME: NASA Lewis CdS Solar Cell Test

CdS Cell = 32.6 mv 2,649.1 hrs of continuous solar

DR-2 = 10.10 mr 342.3 hrs on lamp S/N 016981

ETI = 9,474.5 hrs

The table below depicts spectral data both relatively and in Watts/meter^2 for the solar simulator. The % deviation with respect to the NRL or Johnson data (NASA SP-8005, June 1965, Solar Electromagnetic Radiation) are given in Column 6.

Band No.	Bandwidth (in Microns)	Matched Data	Normalized Matched Data W.R.T. One-Solar Constant (w/m^2)	NRL (w/m^2)	% Deviation
1.	0.25 0.35	7.8	36.9	62.82	-41.3
2.	0.35 0.40	13.1	62.0	61.42	+ 0.9
3.	0.40 0.45	15.3	72.4	95.90	-24.5
4.	0.45 0.50	19.7	93.2	106.10	-12.2
5.	0.50 0.60	38.4	181.7	191.25	- 5.0
6.	0.60 0.70	36.6	173.2	161.94	+ 6.9
7.	0.70 0.80	26.8	126.8	127.03	- 0.2
8.	0.80 0.90	21.3	100.8	100.52	+ 0.3
9.	0.90 1.00	20.1	95.1	80.96	+17.5
10.	1.00 1.20	27.7	131.1	121.46	+ 7.9
11.	1.20 1.50	27.7	131.1	111.68	+17.3
12.	1.50 1.80	15.9	75.2	61.84	+21.6
13.	1.80 2.20	10.0	47.3	44.25	+ 6.9
14.	2.20 2.50	4.1	19.4	19.13	+ 1.4

number 64 agrees within 8.0 percent. Since the thermocouples are reading correctly, the solar intensity is correct, and the instrumentation is correct, then the spread in the data between in-situ measurements and control block data are probably due to changes that occur in the CdS solar cells.

The load performance figures show cell degradation in vacuum and the precycling and postcycling tables show the changes in the cell performance before and after testing. No attempt was made to correlate the in-situ measurements with the control block measurements because of the unknown variables in the CdS solar cell.

6.0 CONCLUSIONS

As a result of the testing conducted in this program, the following conclusions have been reached:

1. Almost all CdS solar cells degraded in power when exposed to a simulated space environment involving either thermal cycling or constant illumination.

2. A comparison of the degradation of cells thermally cycled and constantly illuminated at the same number of test hours agreed well. Hence the mode of illumination was not important.

3. Among the parameters investigated in these tests it appears that the manufacturing date was an important factor in the degradation of the cells.

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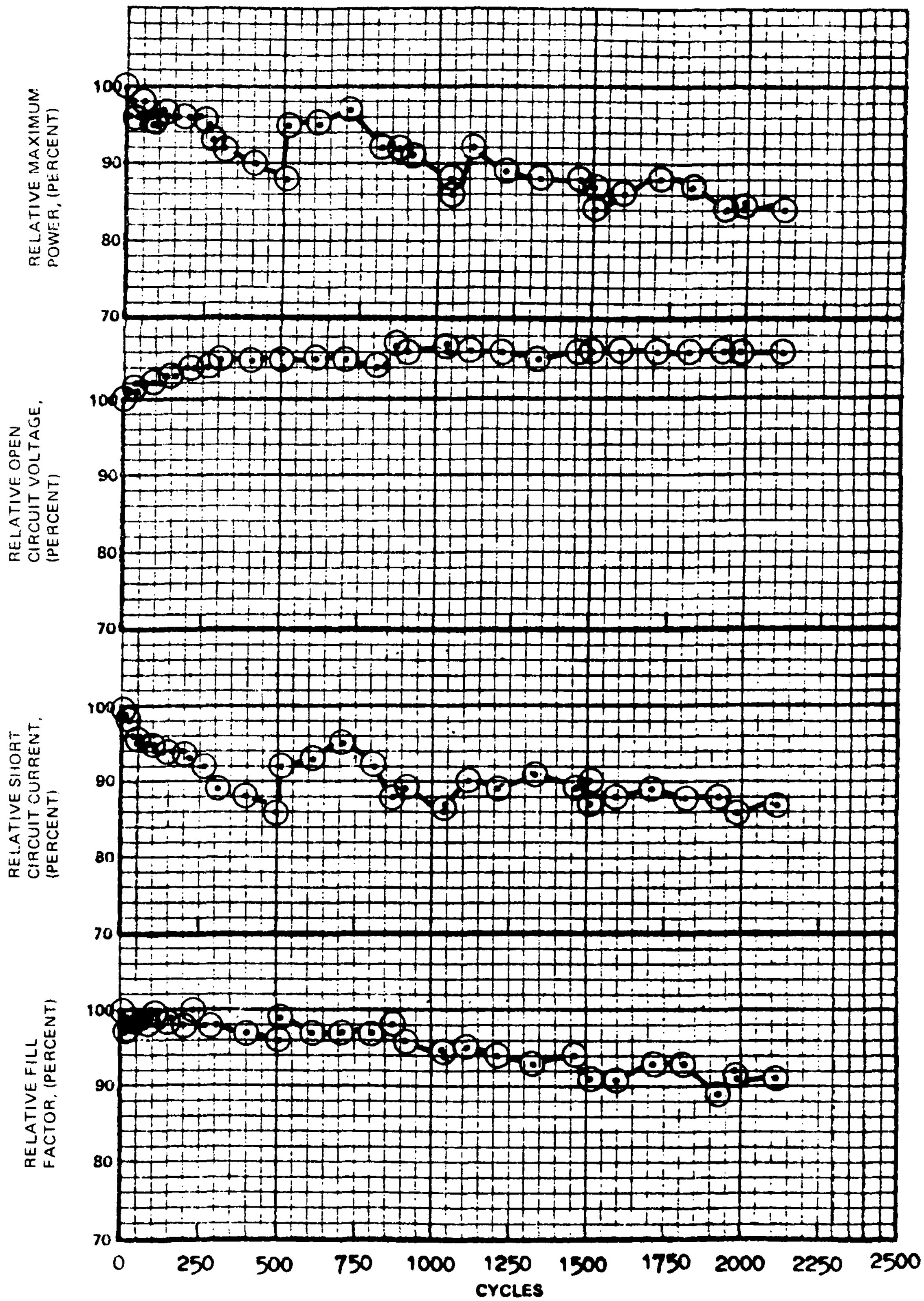

Figure 20: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR TEST CELL NO. 1

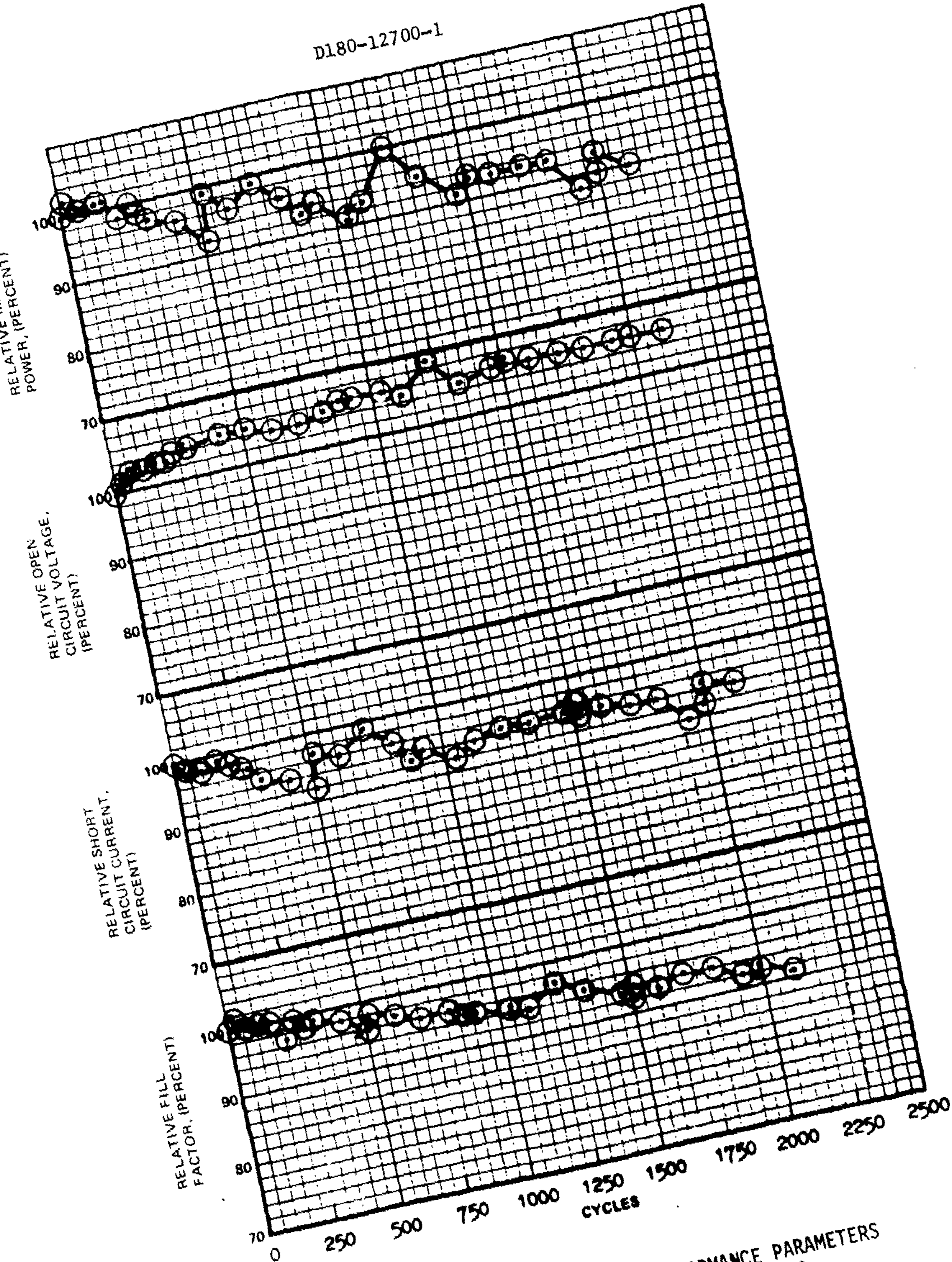

Figure 21: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR TEST CELL NO. 2

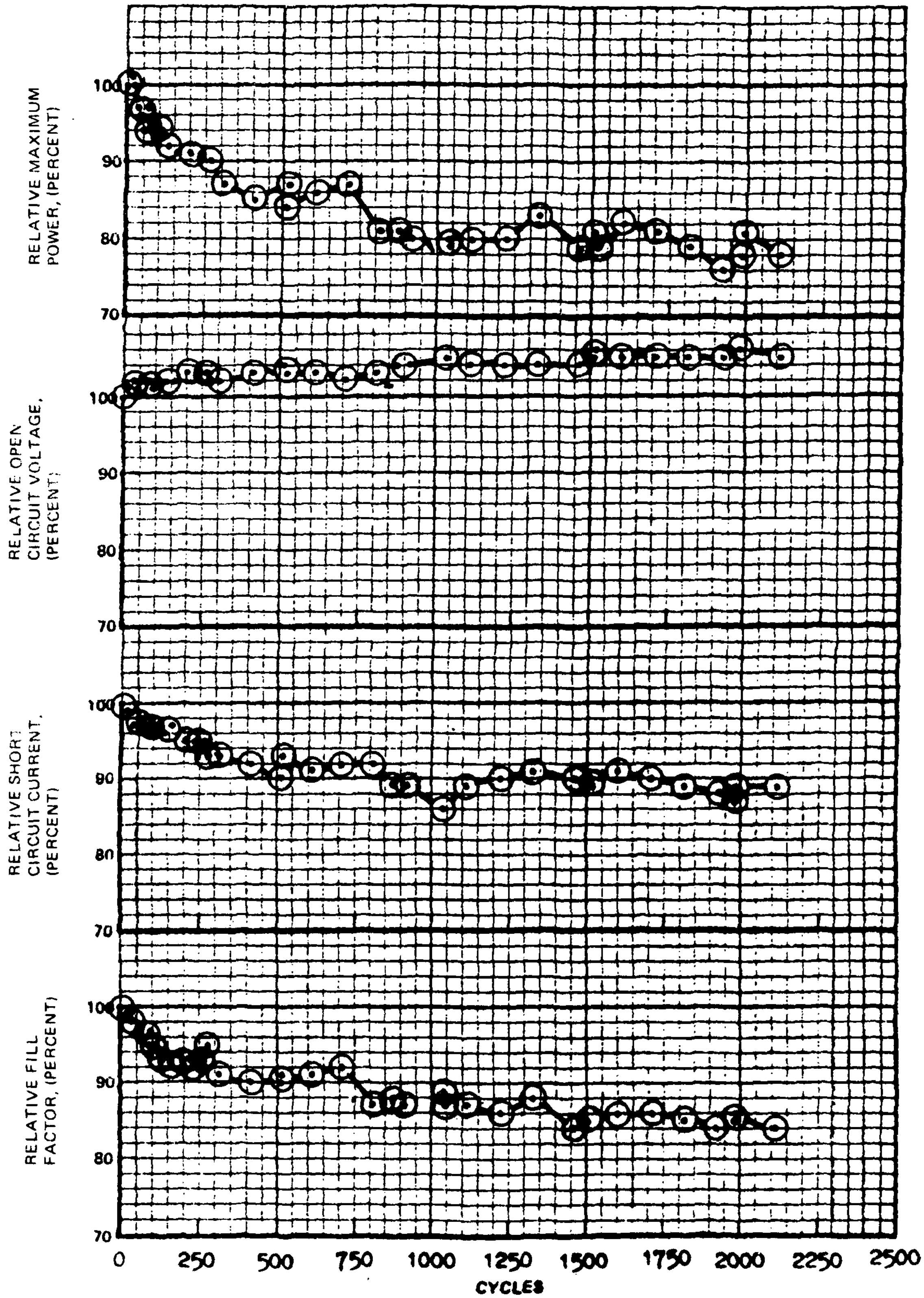

Figure 22: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR TEST CELL NO. 3

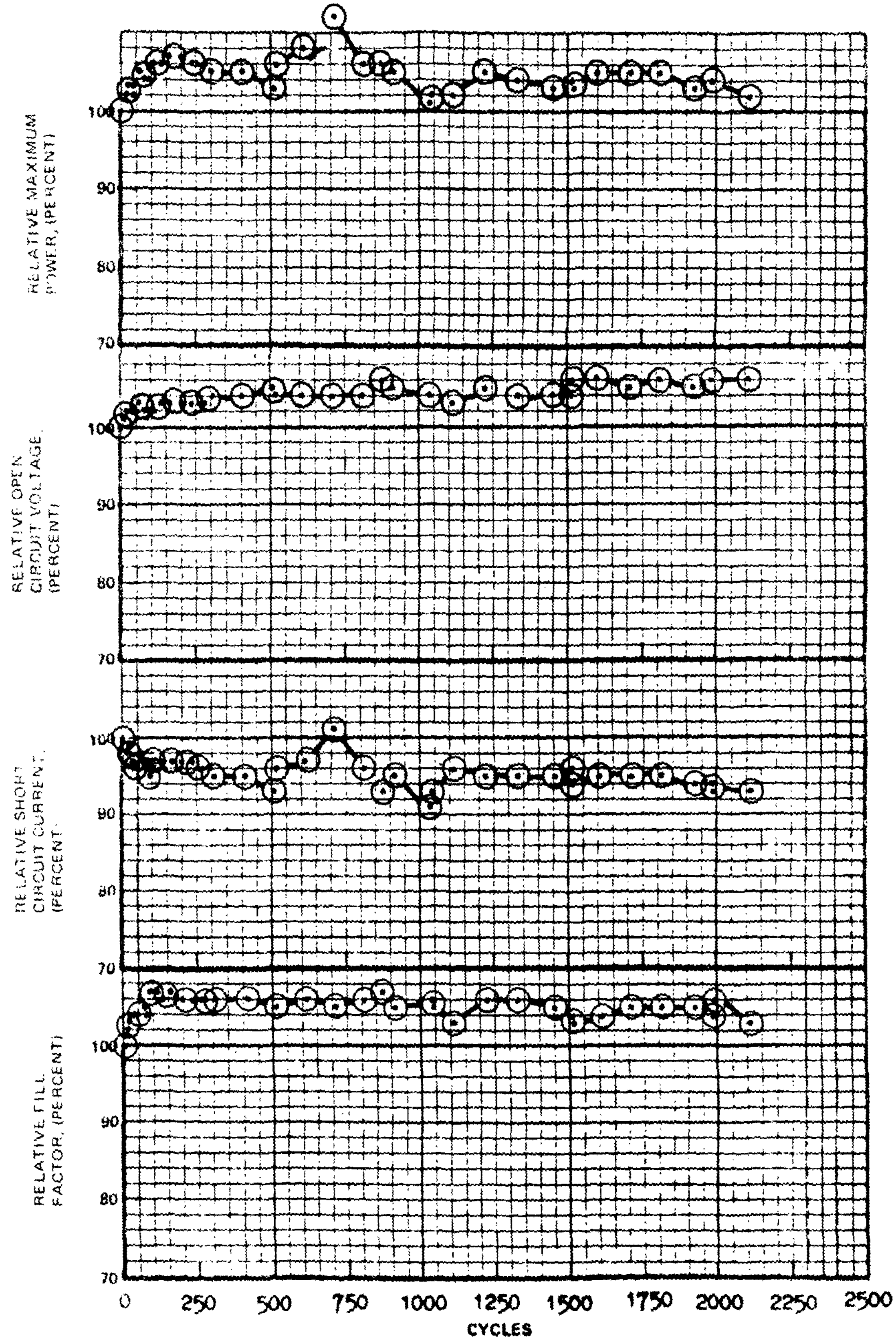

Figure 23: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR TEST CELL NO. 4

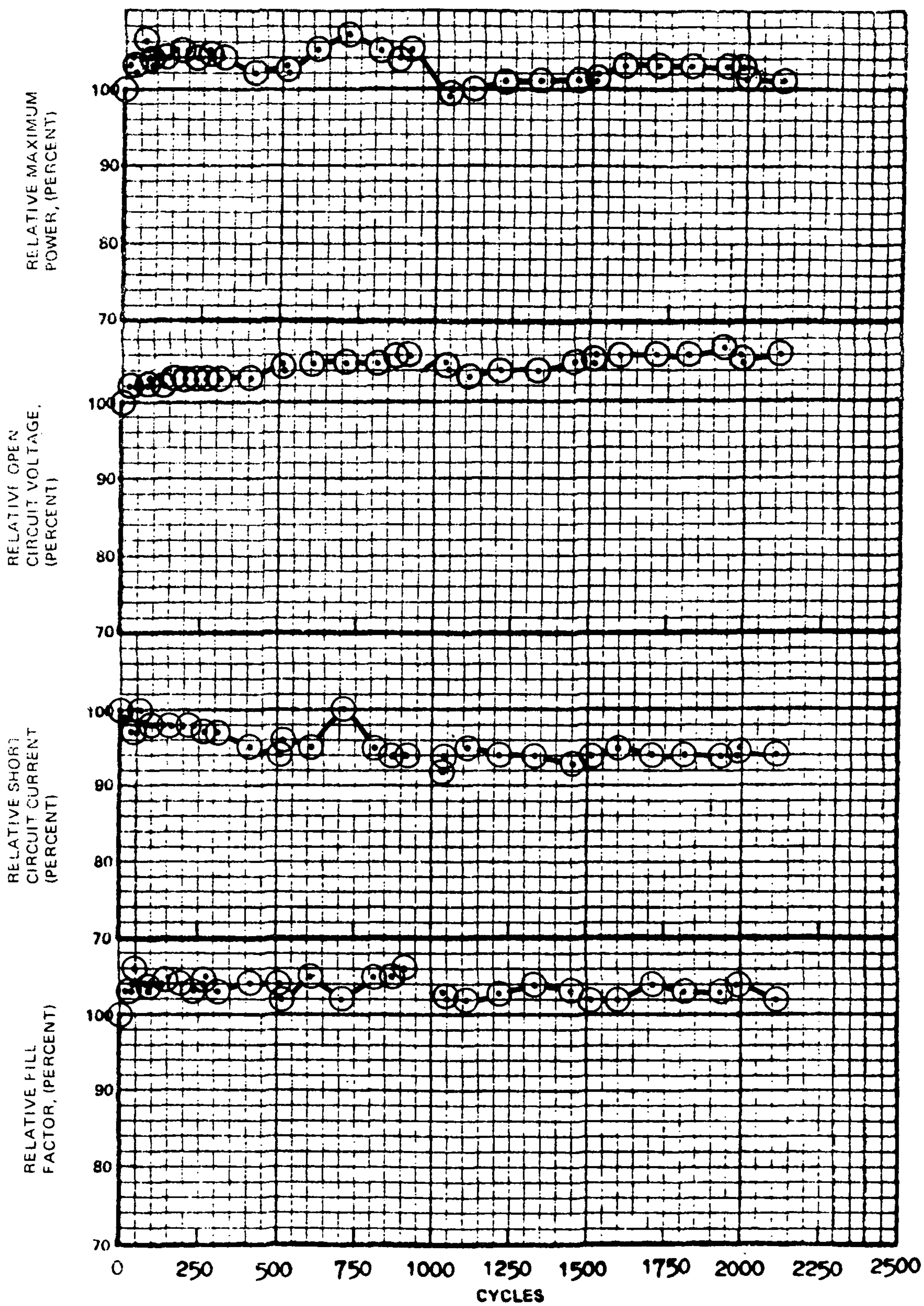

Figure 24: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR TEST CELL NO. 5

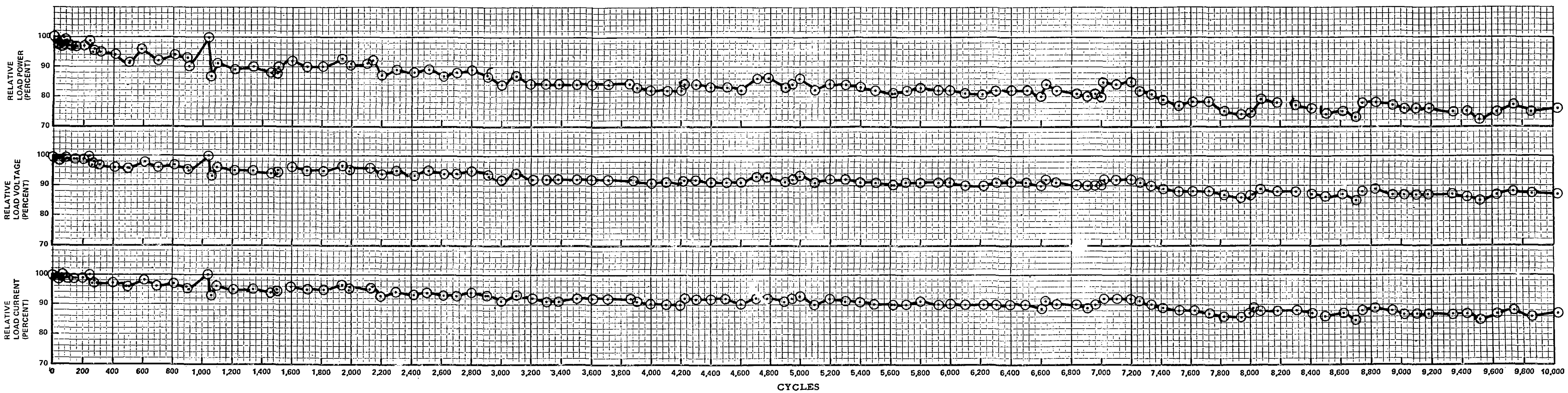

Figure 25 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 6

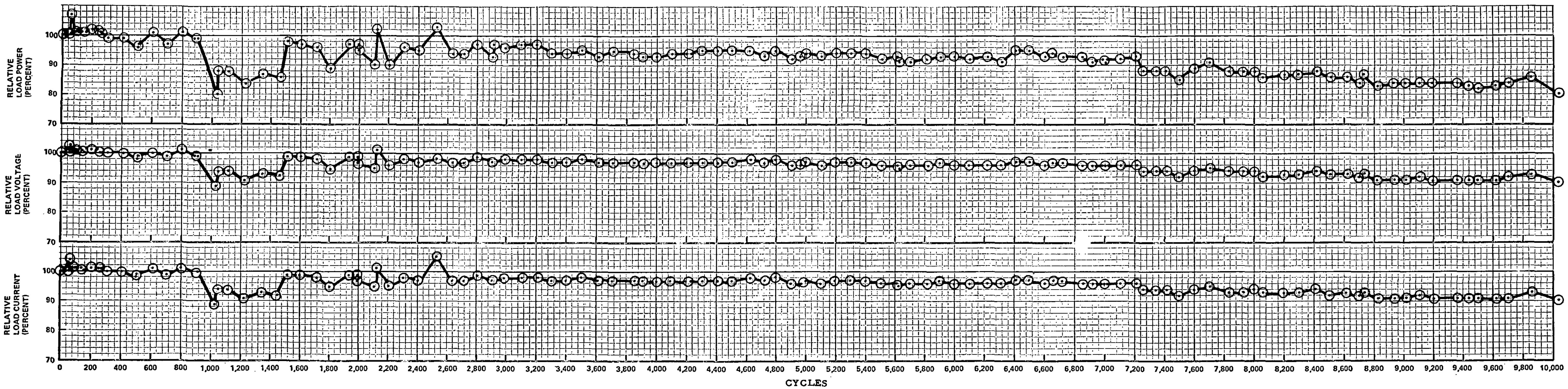

Figure 25 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 7

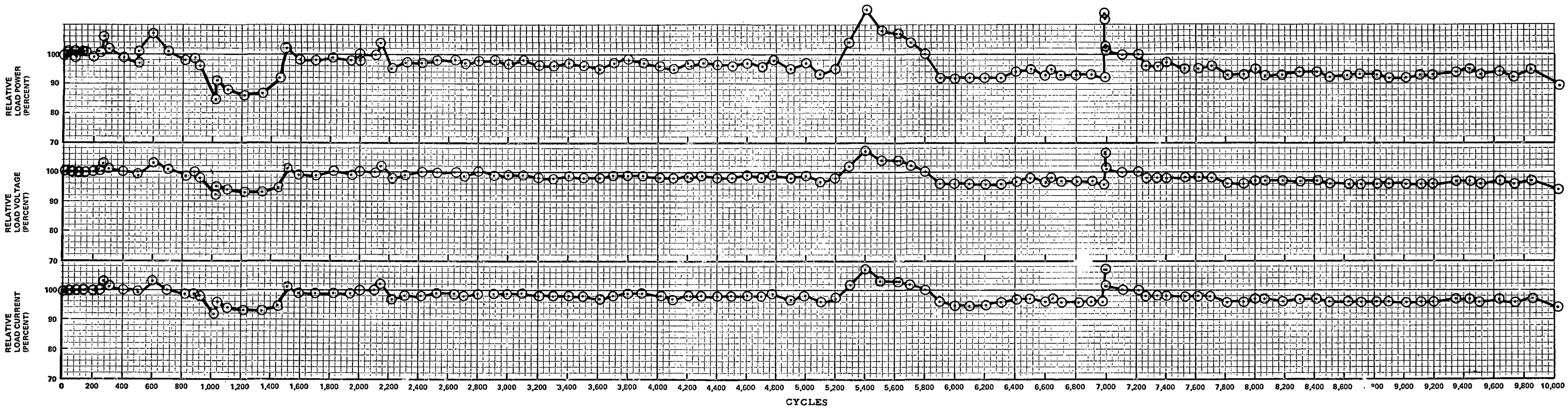

Figure 27 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 8

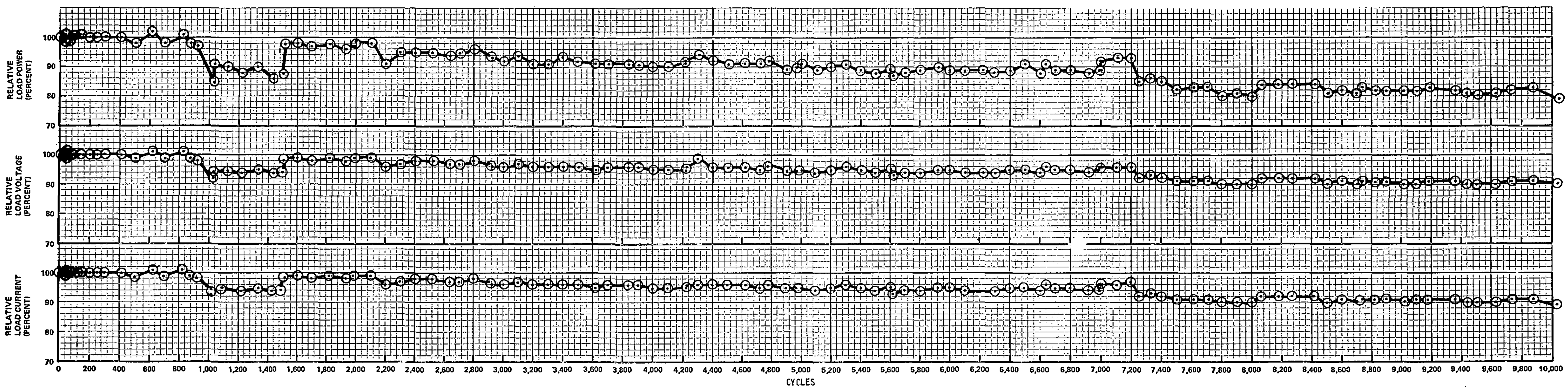

Figure 28 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 9

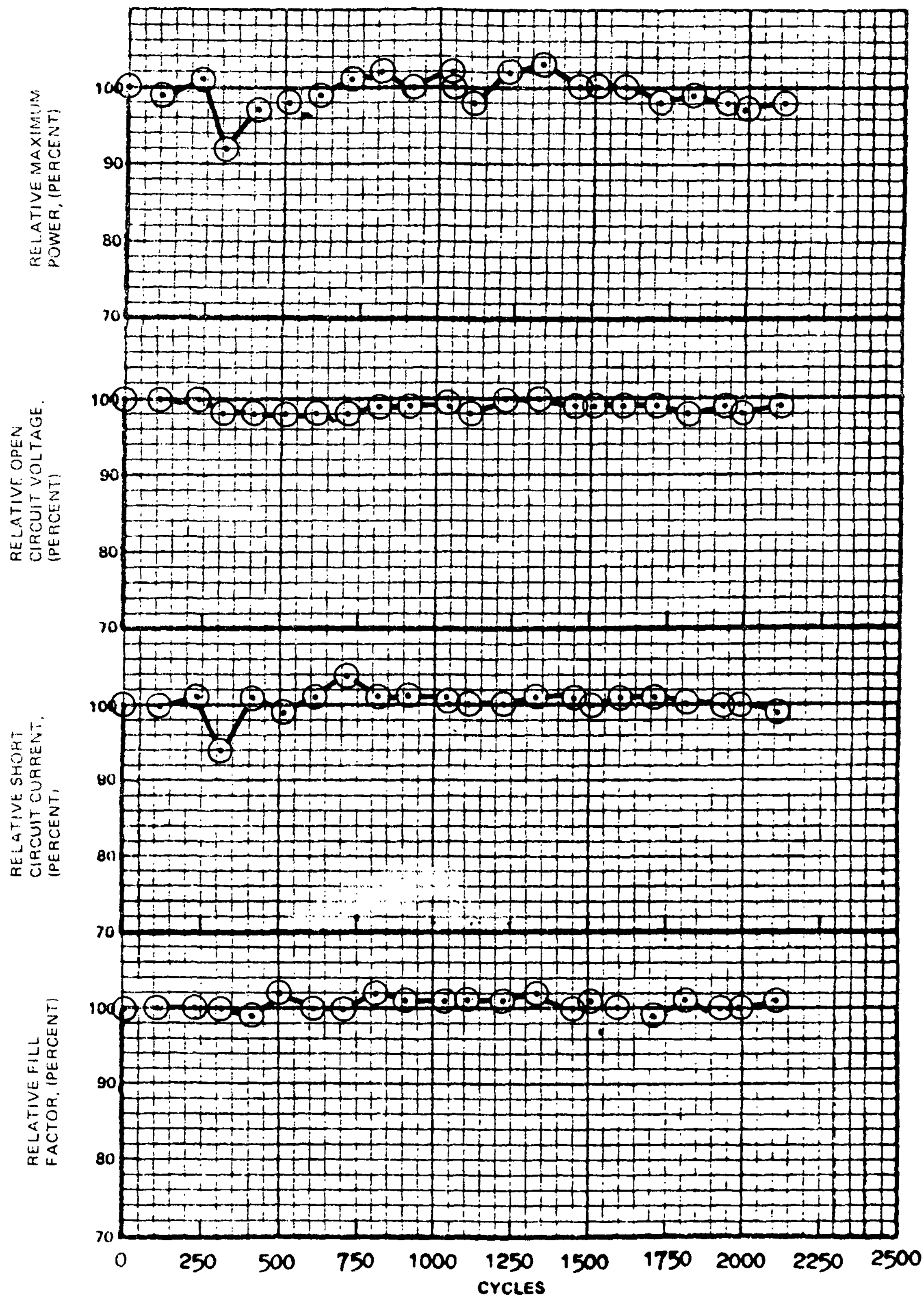

Figure 29: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR CONTROL CELL NO. 10

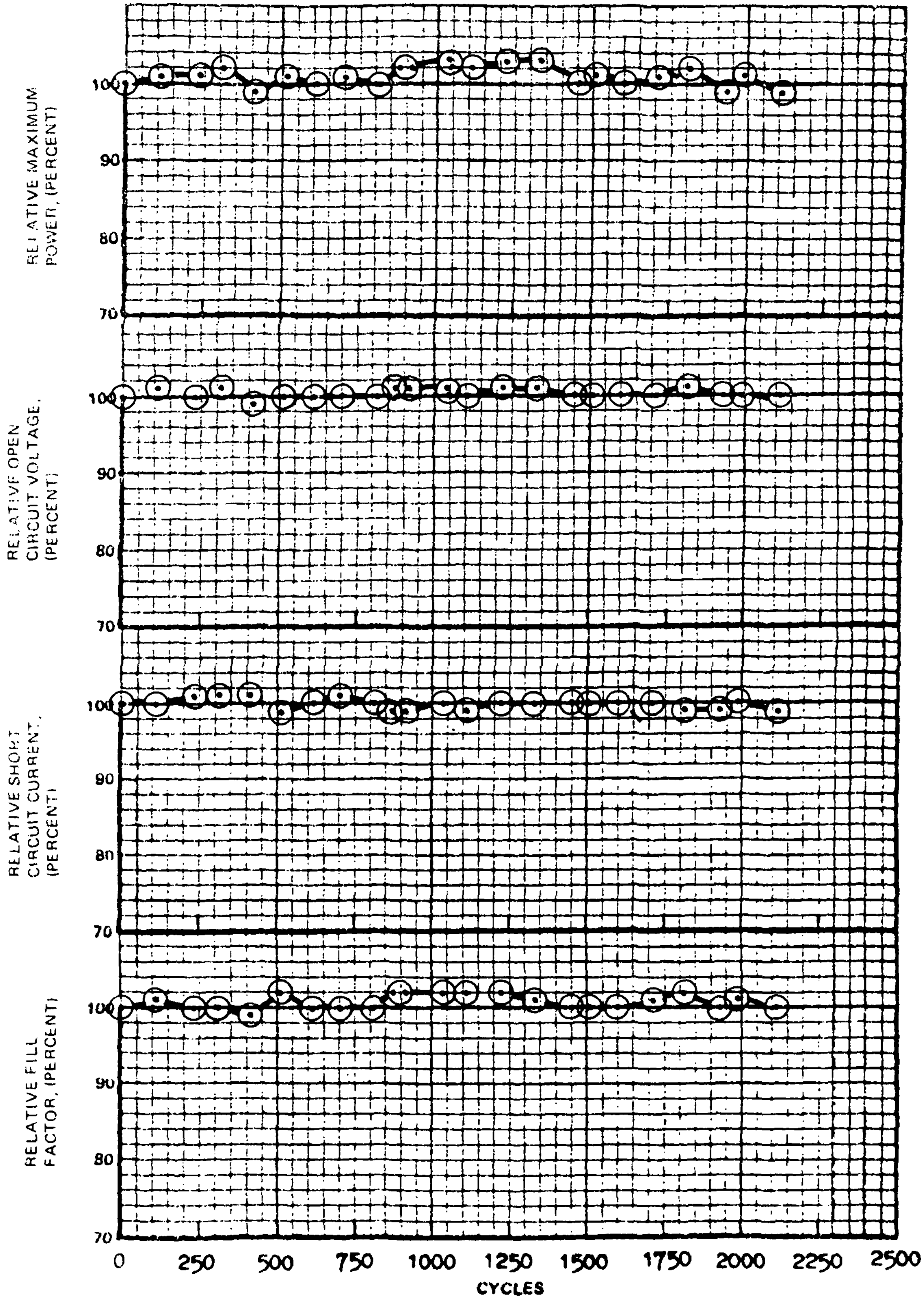

Figure 30: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR CONTROL CELL NO. 11

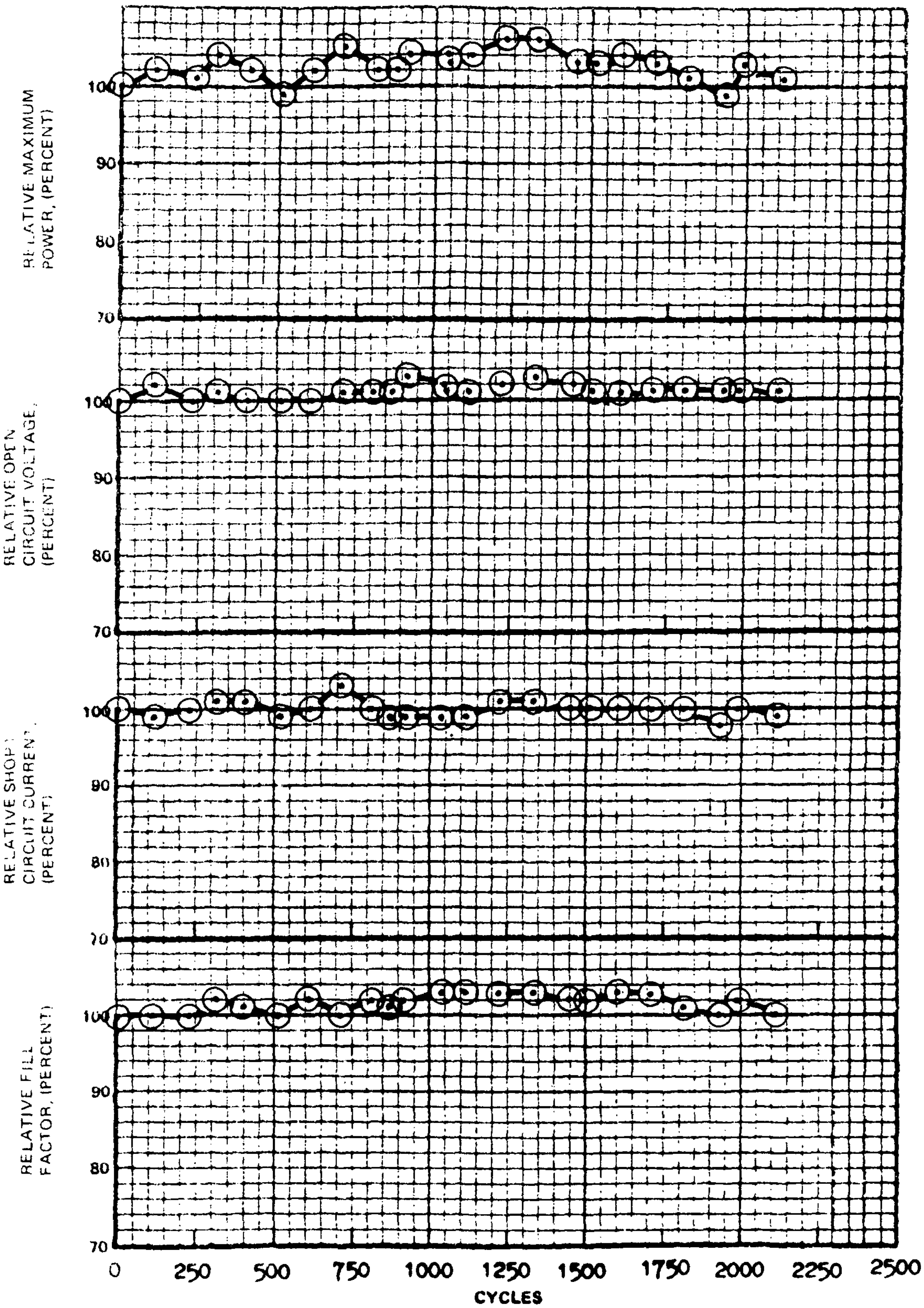

Figure 31: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR CONTROL CELL NO. 12

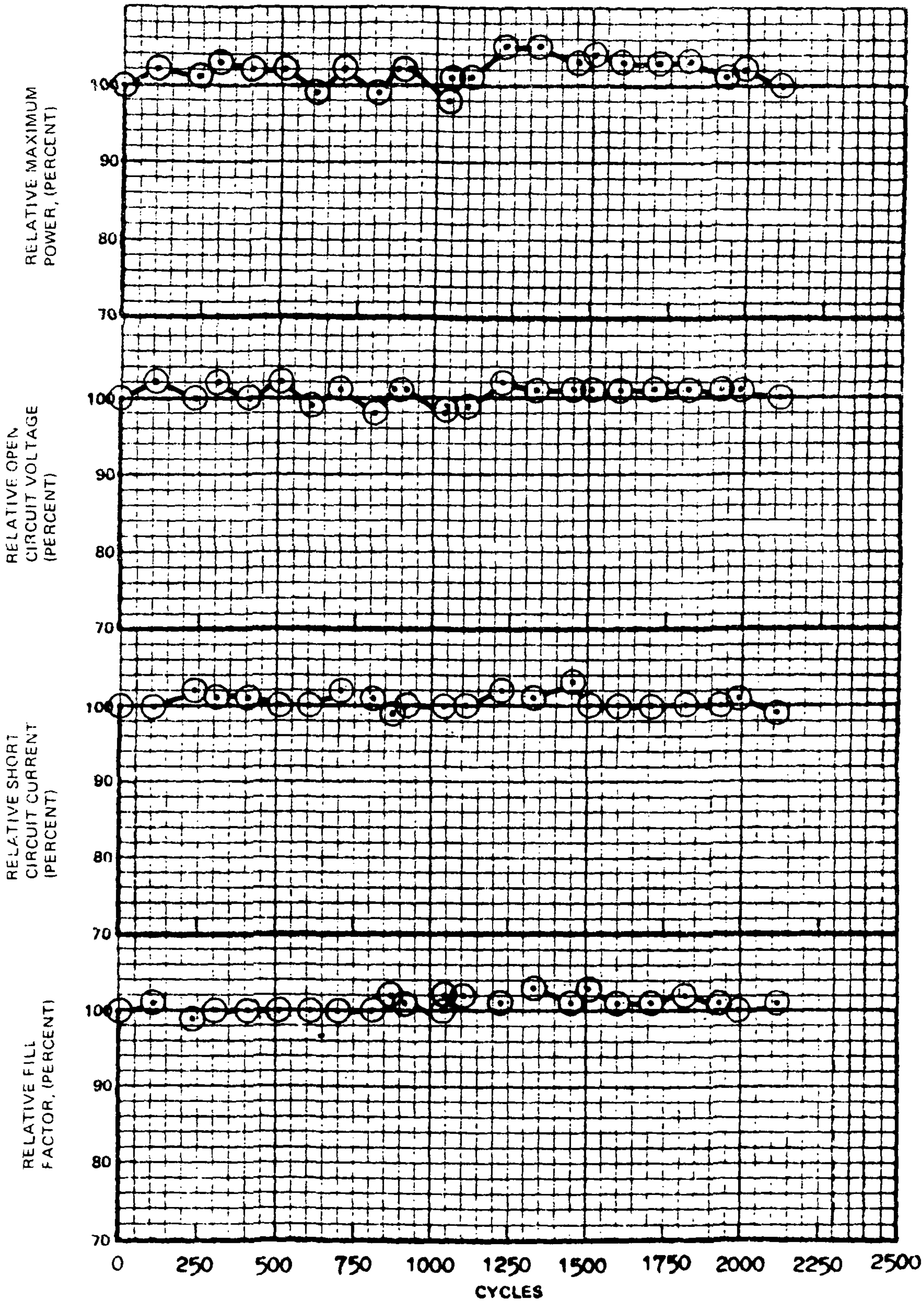

Figure 32: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR CONTROL CELL NO. 13

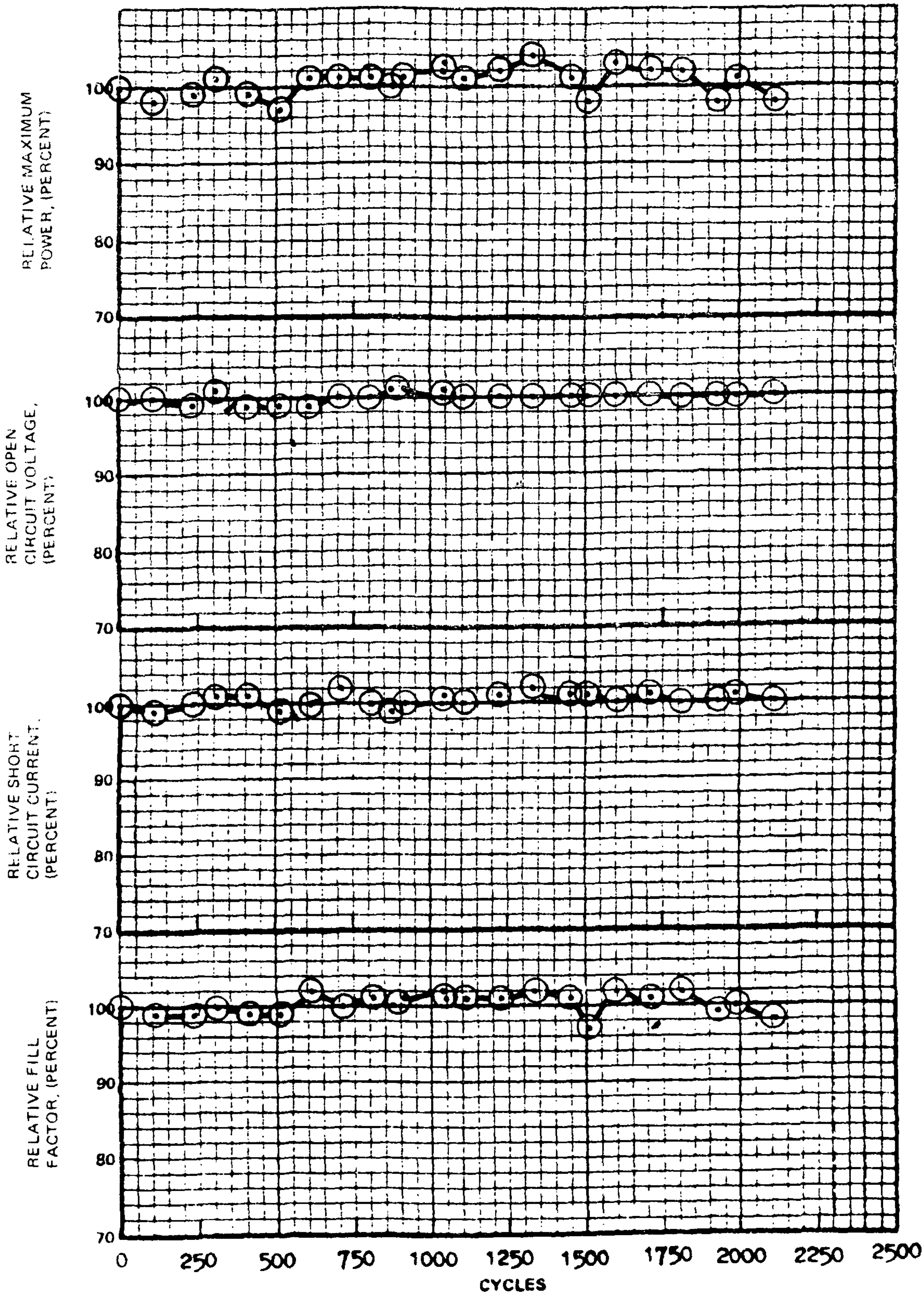

Figure 33: RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES FOR CONTROL CELL NO. 14

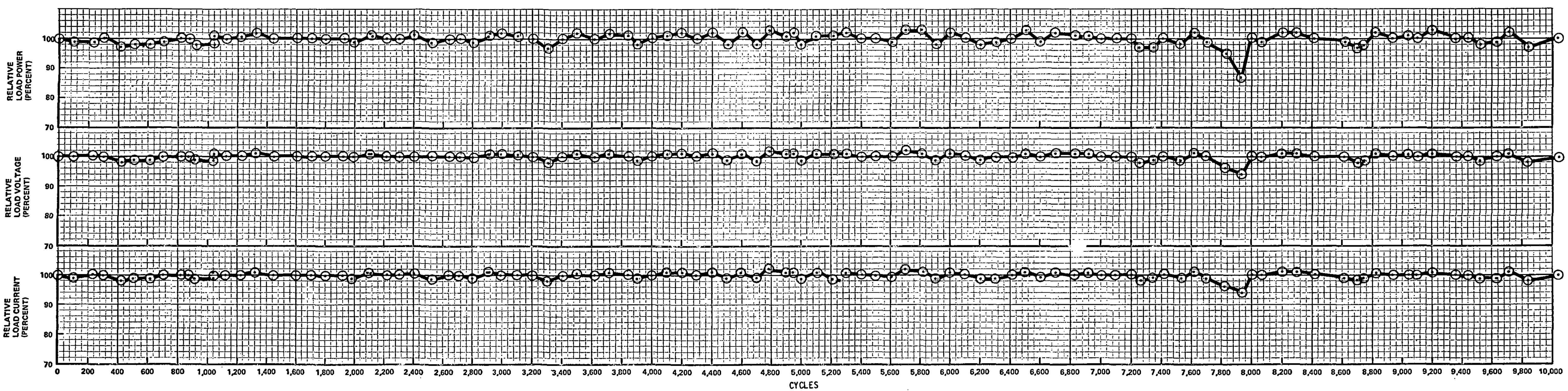

Figure 34 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 15

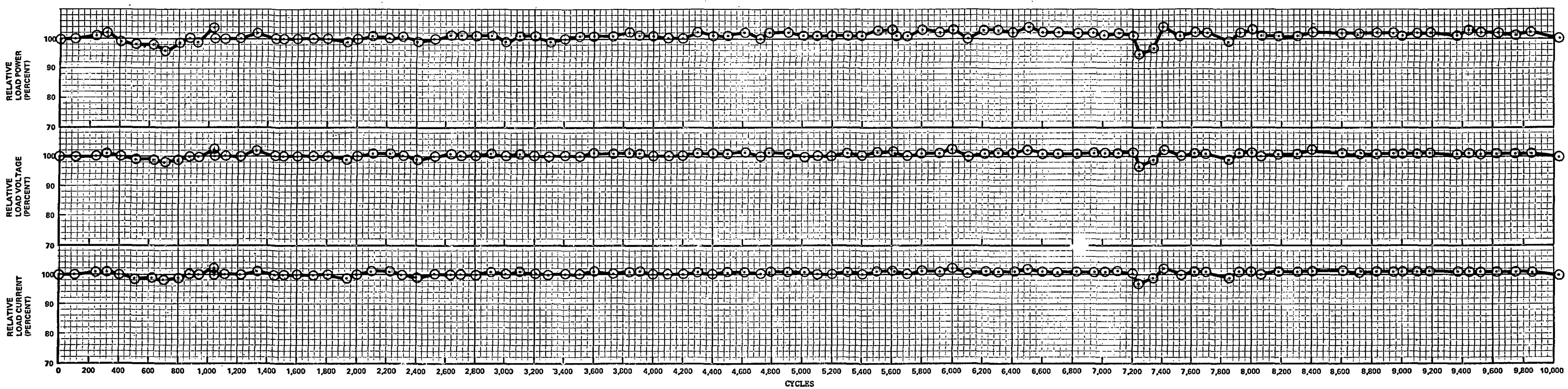

Figure 35 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 16

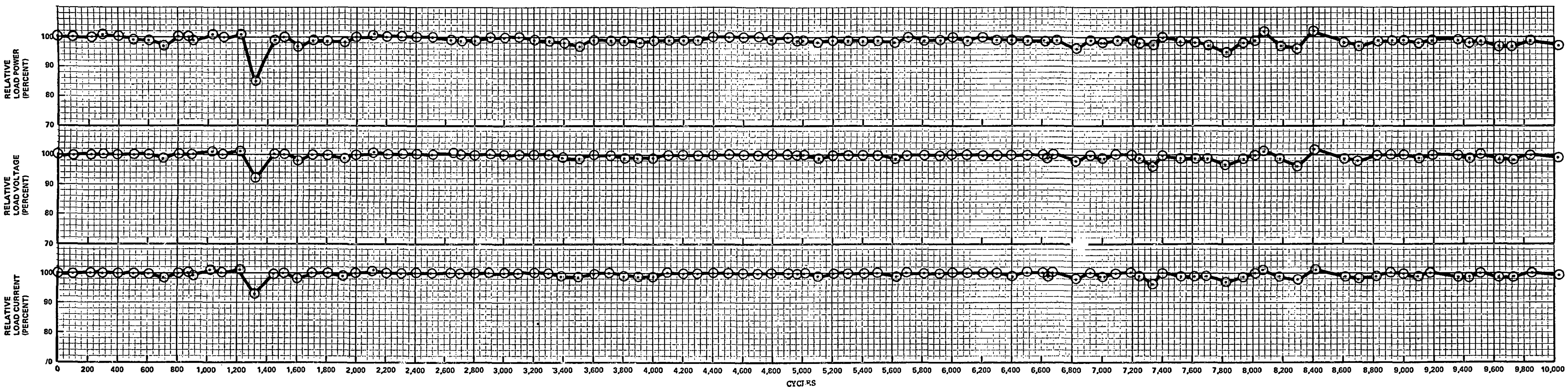

Figure 36 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 17

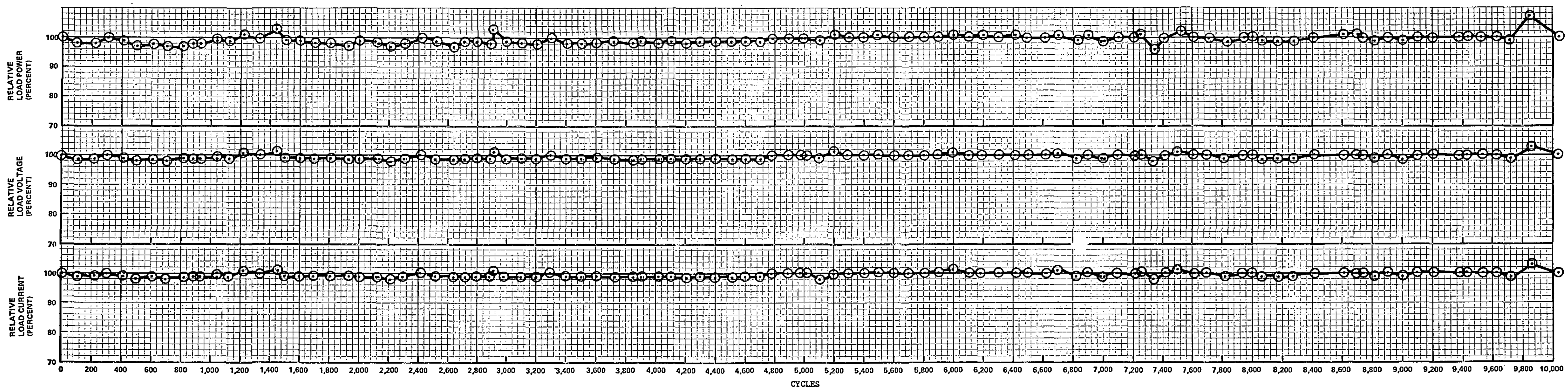

Figure 37 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 18

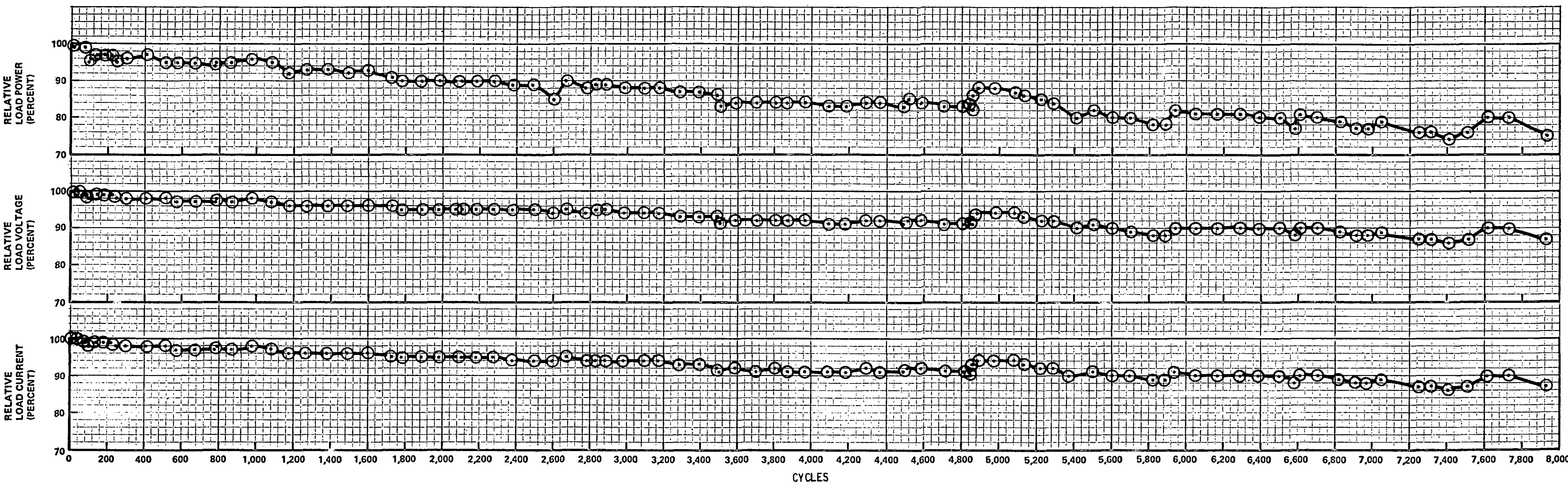

Figure 38 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 19

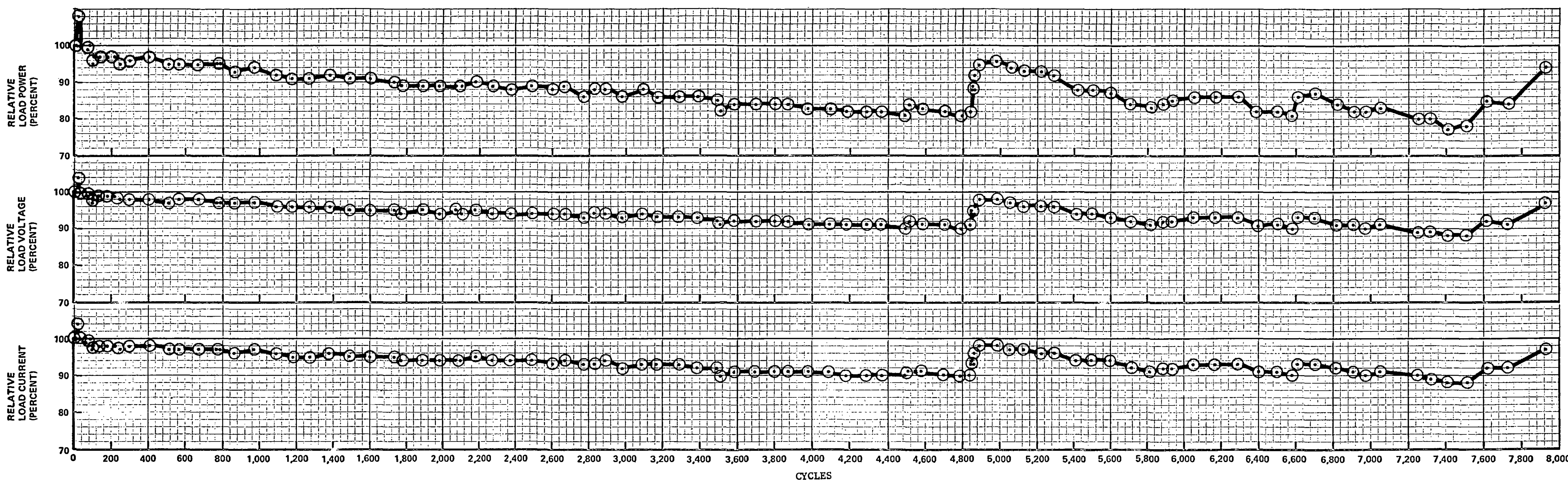

Figure 39 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 20

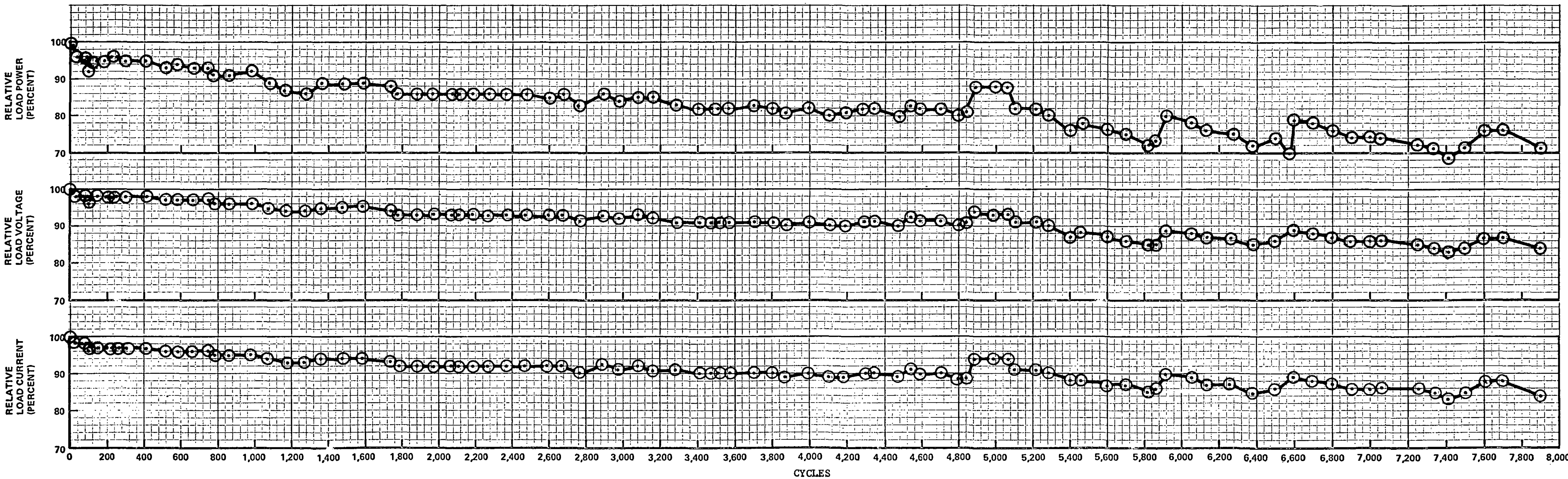

Figure 40 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 21

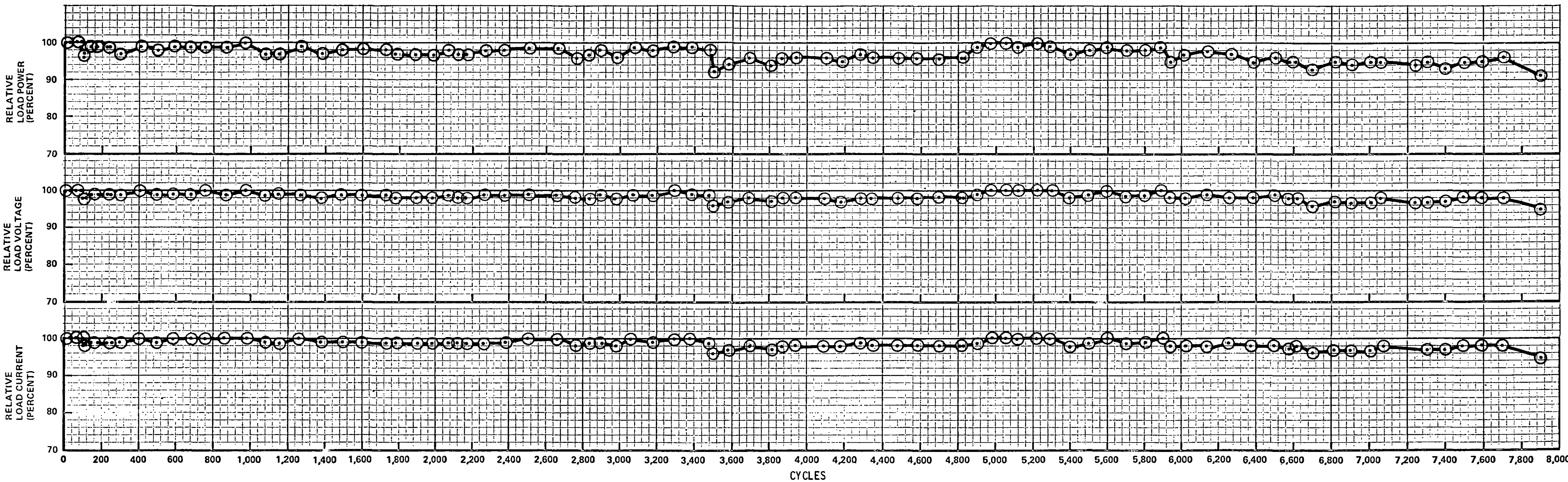

Figure 41 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 22

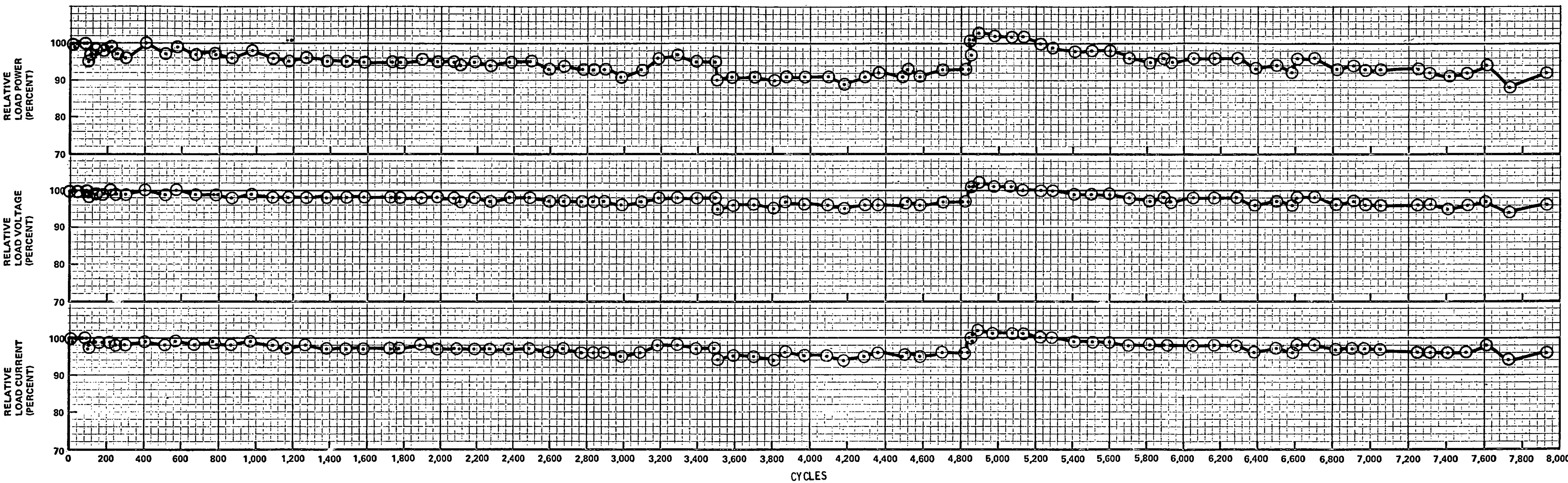

Figure 42 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR TEST CELL NO. 23

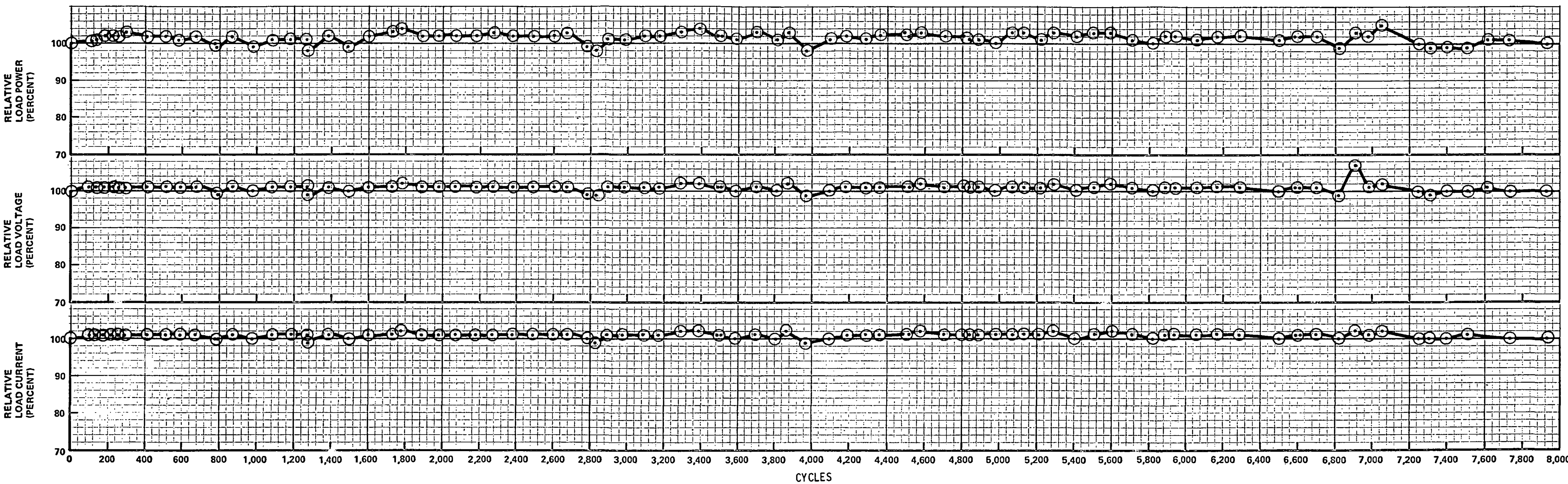

Figure 43 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 24

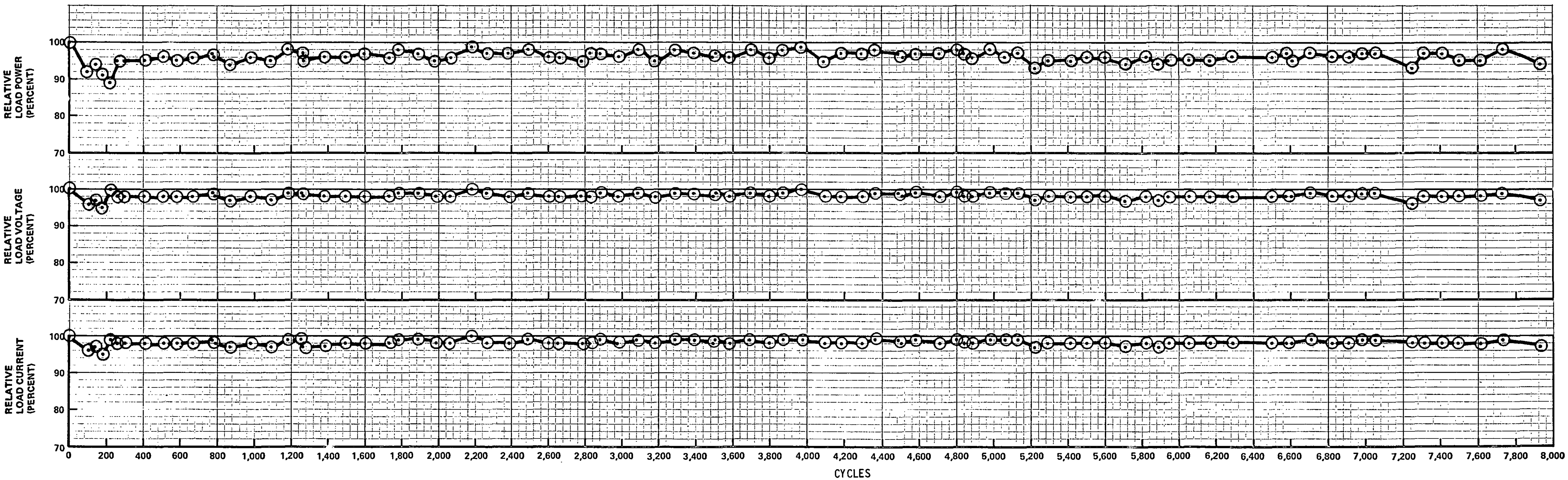

Figure 44 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 25

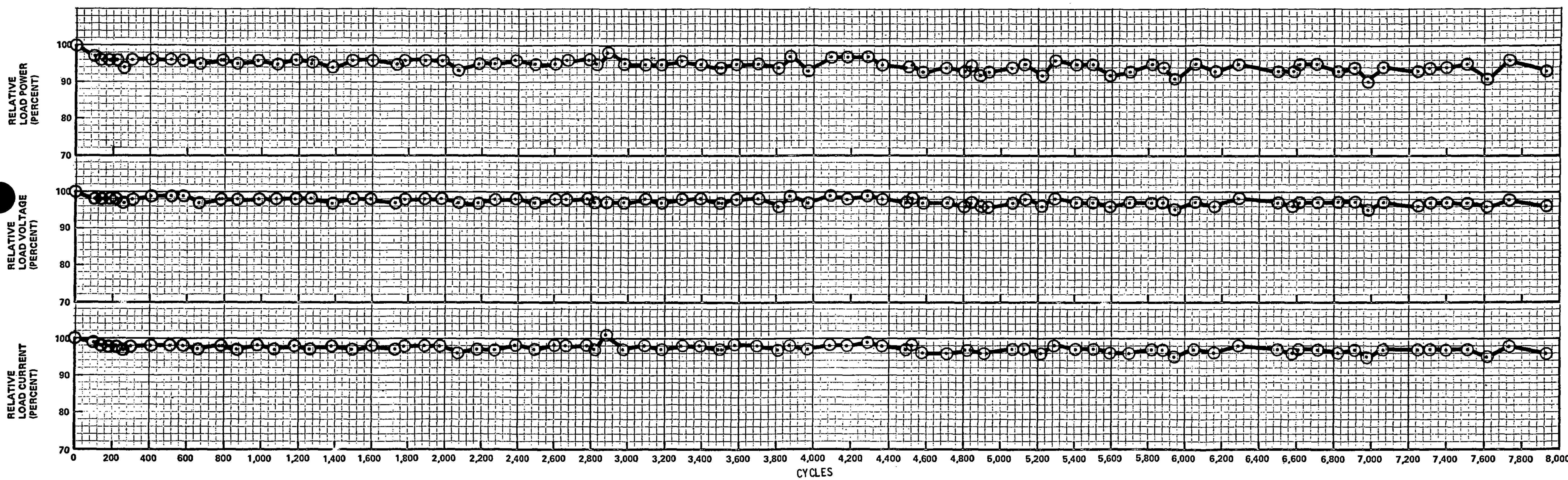

Figure 45 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 26

Figure 46 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 27

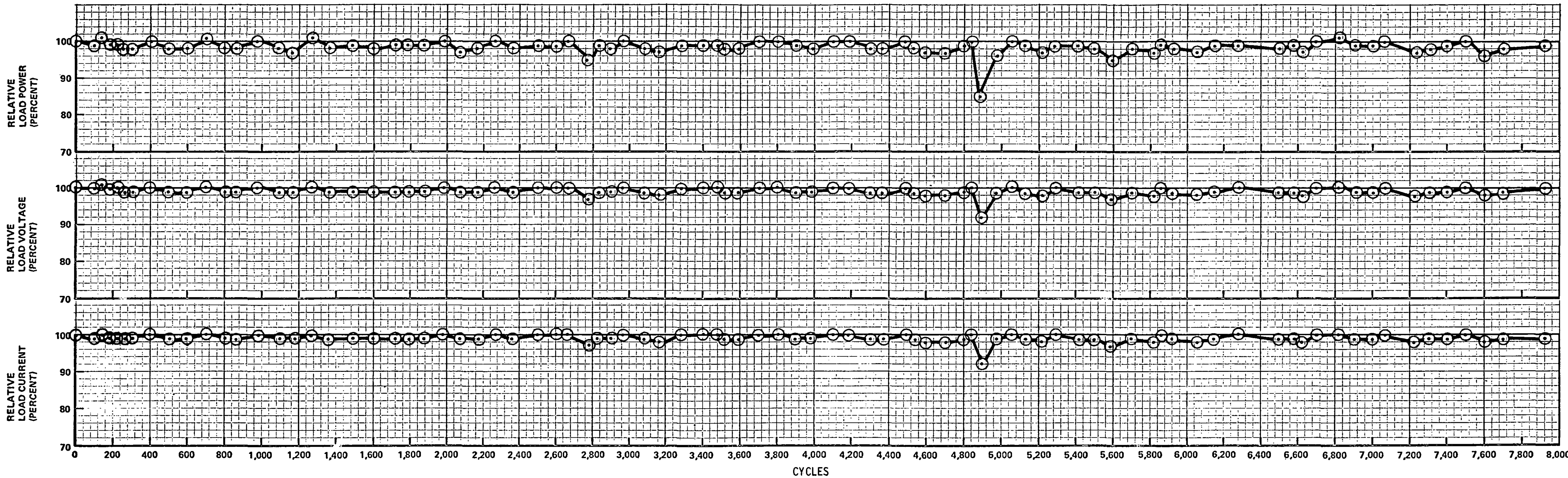

Figure 47 RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS CYCLES FOR CONTROL CELL NO. 28

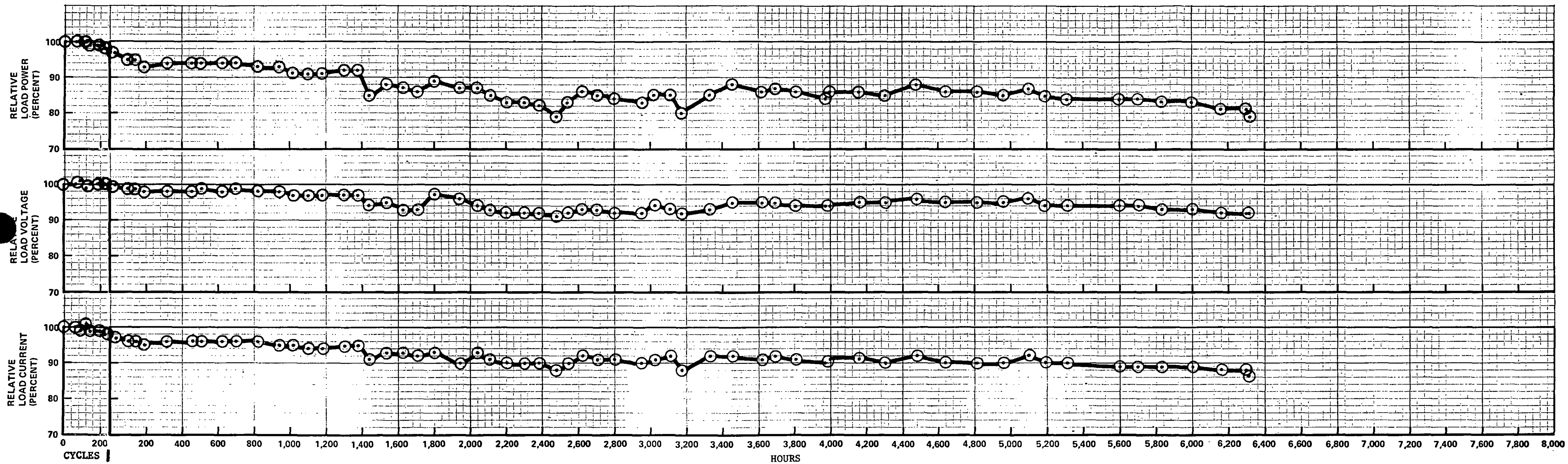

Figure 48 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 29

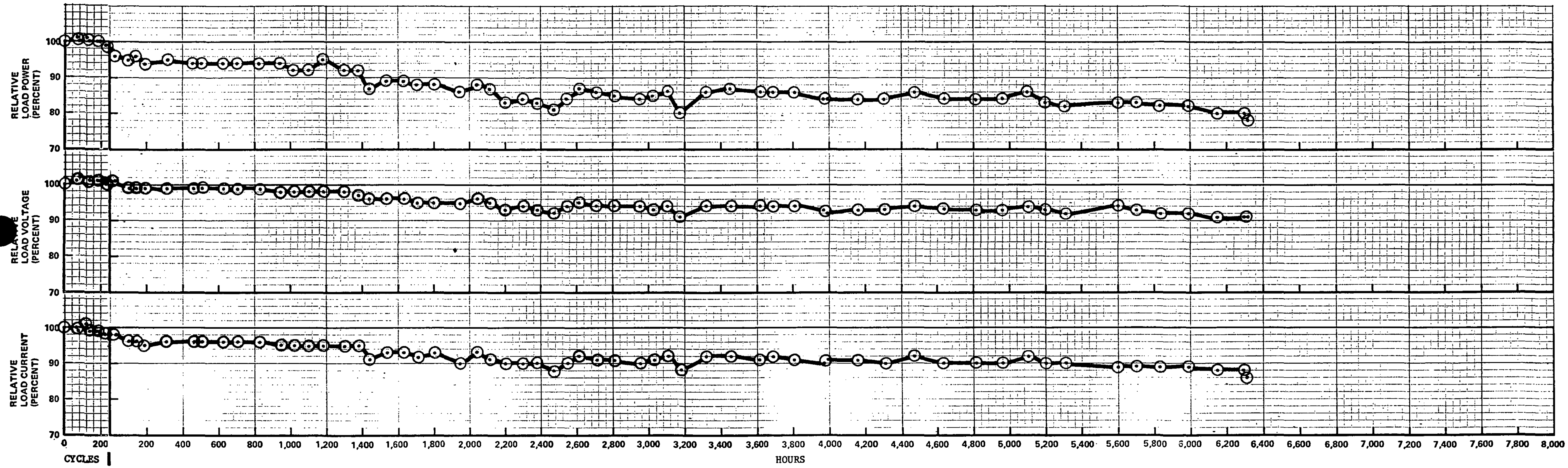

Figure 49 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 30

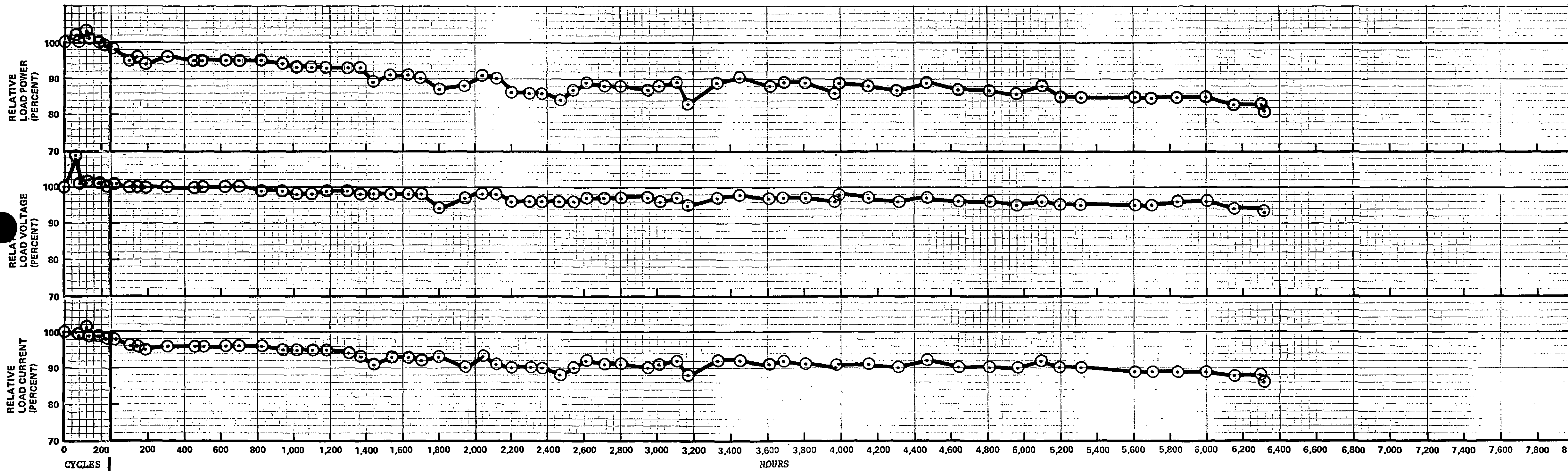

Figure 50 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 31

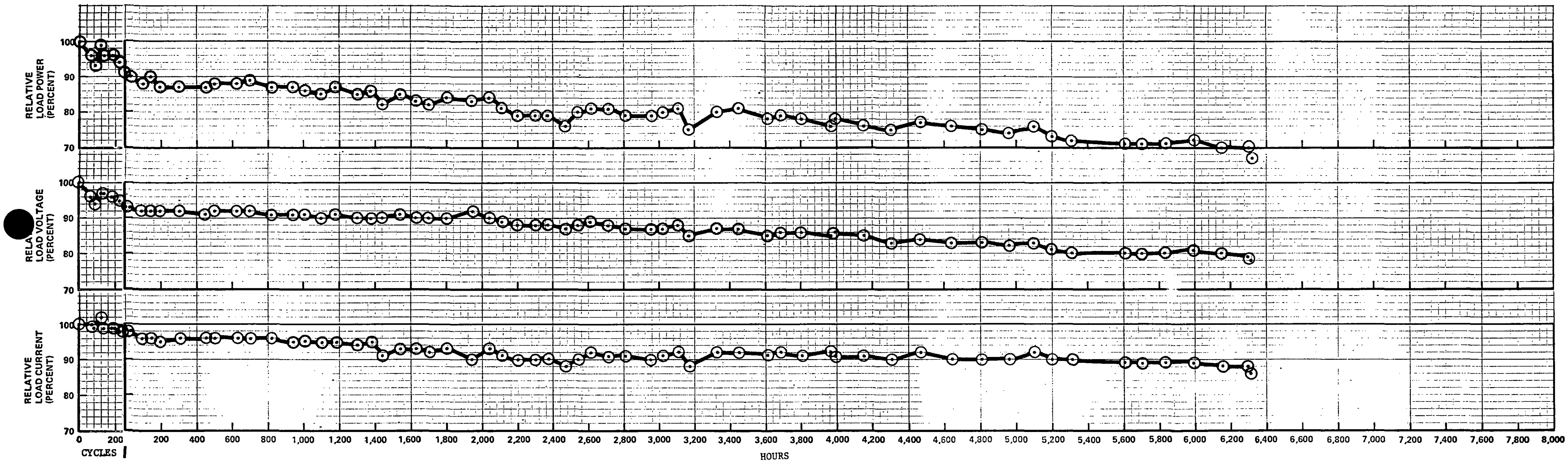

Figure 51 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 32

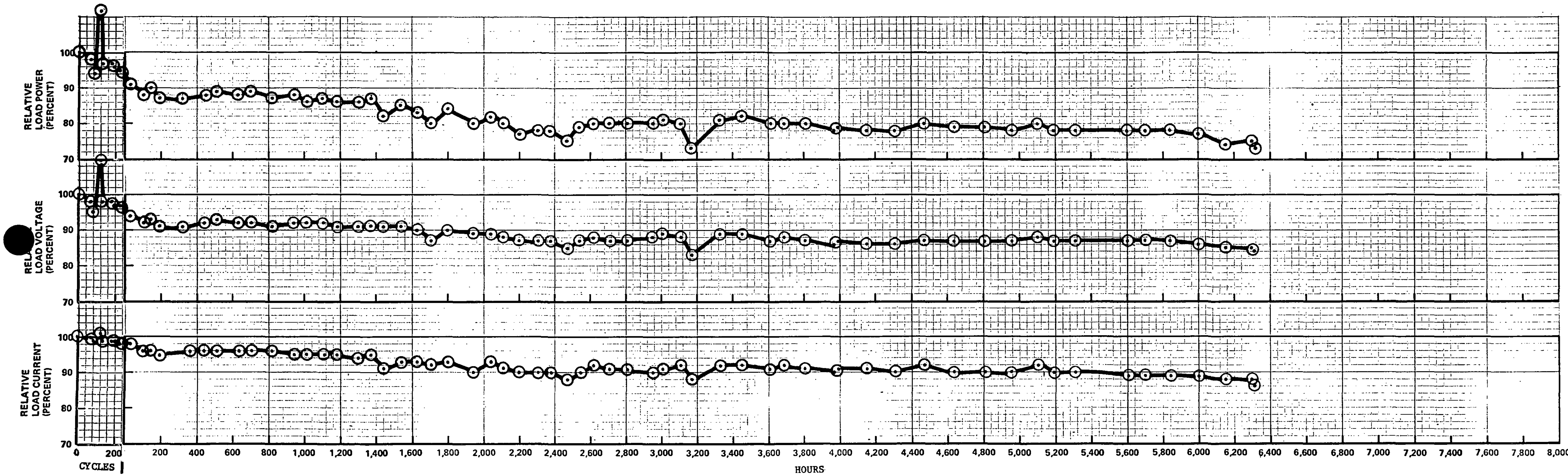

Figure 52 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 33

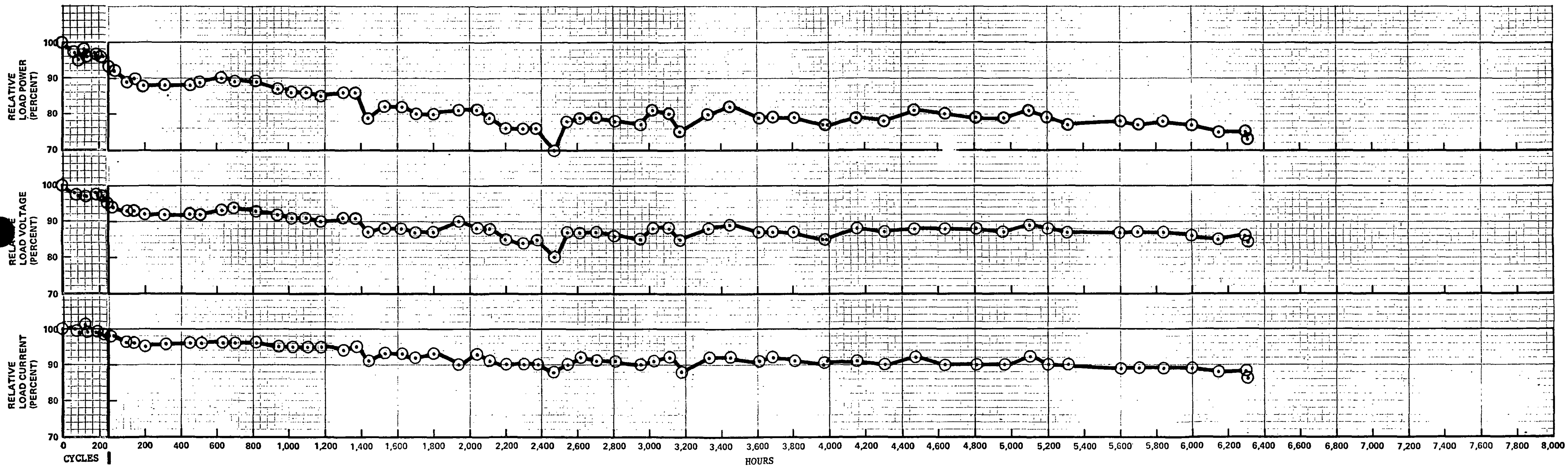

Figure 53 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 34

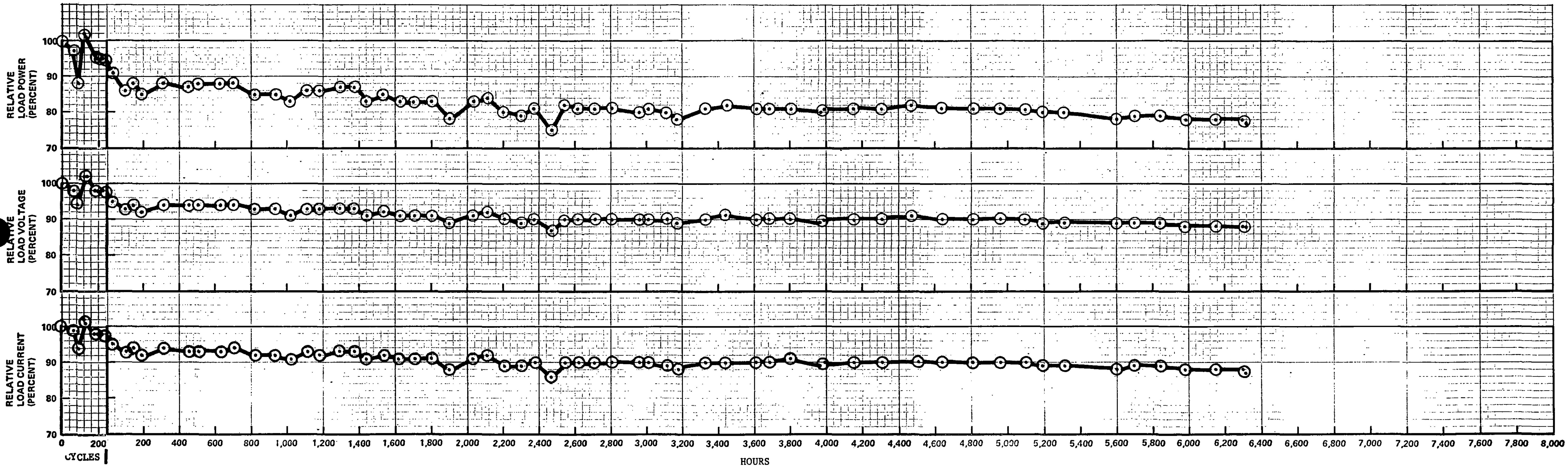

Figure 54 RELATIVE LOAD PERFORMANCE PARAMETERS
VS CYCLES AND HOURS FOR TEST CELL 35

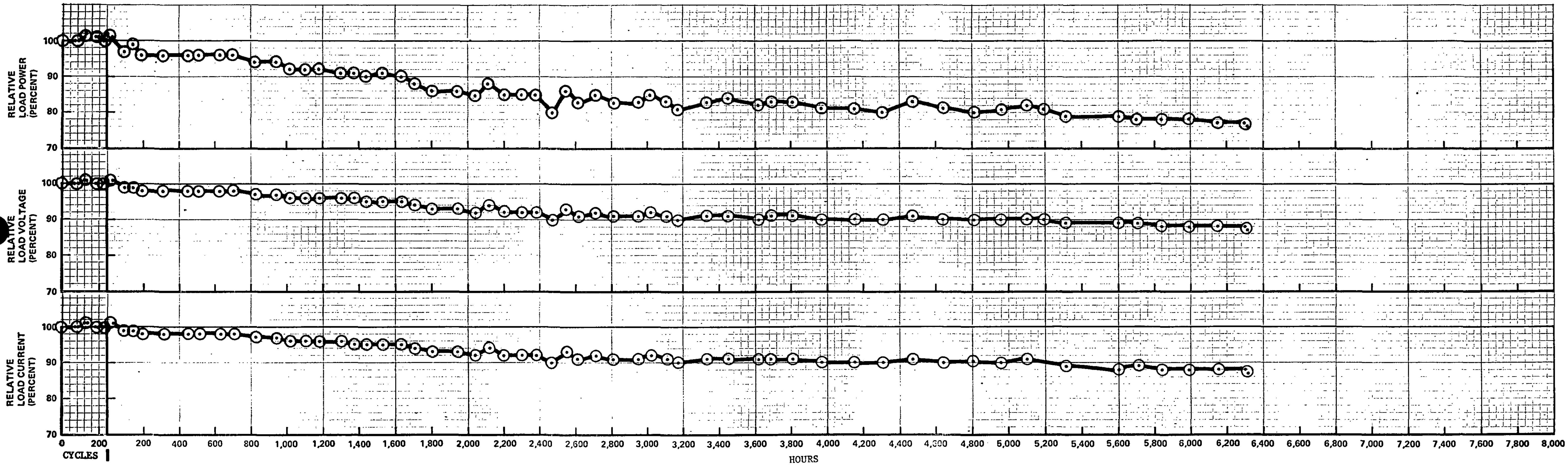

Figure 55 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 36

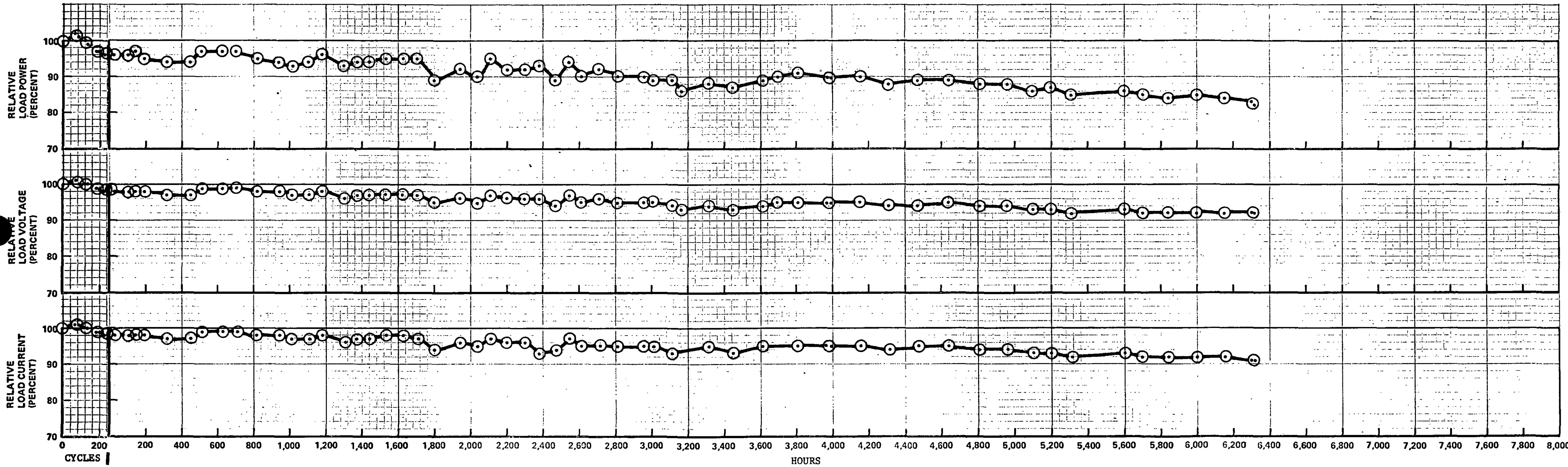

Figure 56 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR TEST CELL 37

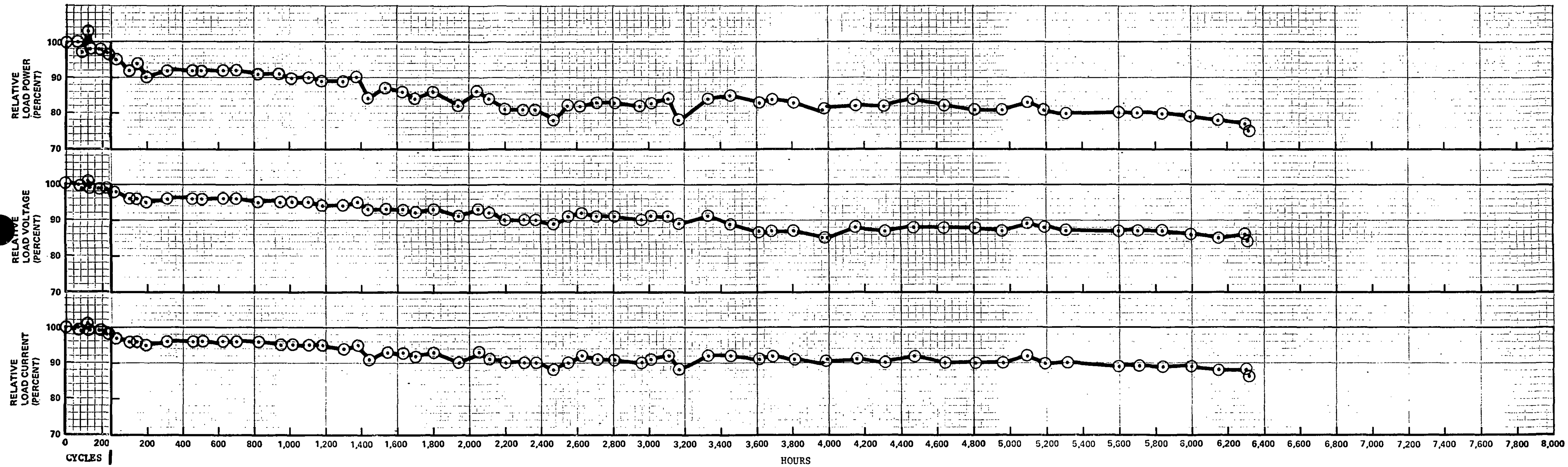

Figure 57 RELATIVE LOAD PERFORMANCE PARAMETERS
VS CYCLES AND HOURS FOR TEST STRING

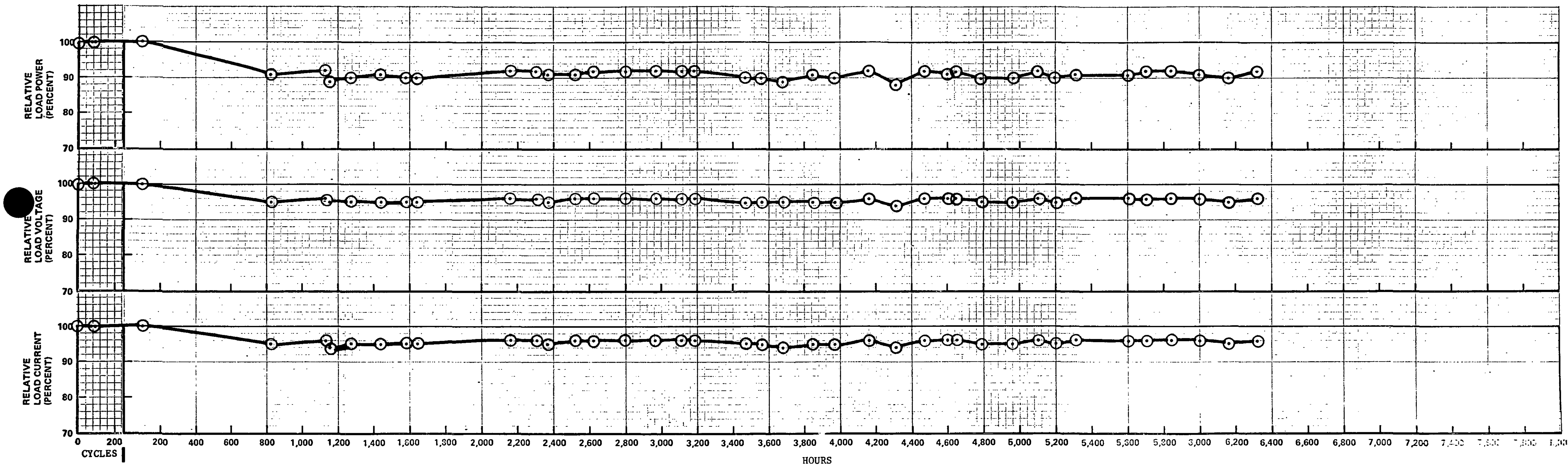

Figure 58 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR CONTROL CELL 44

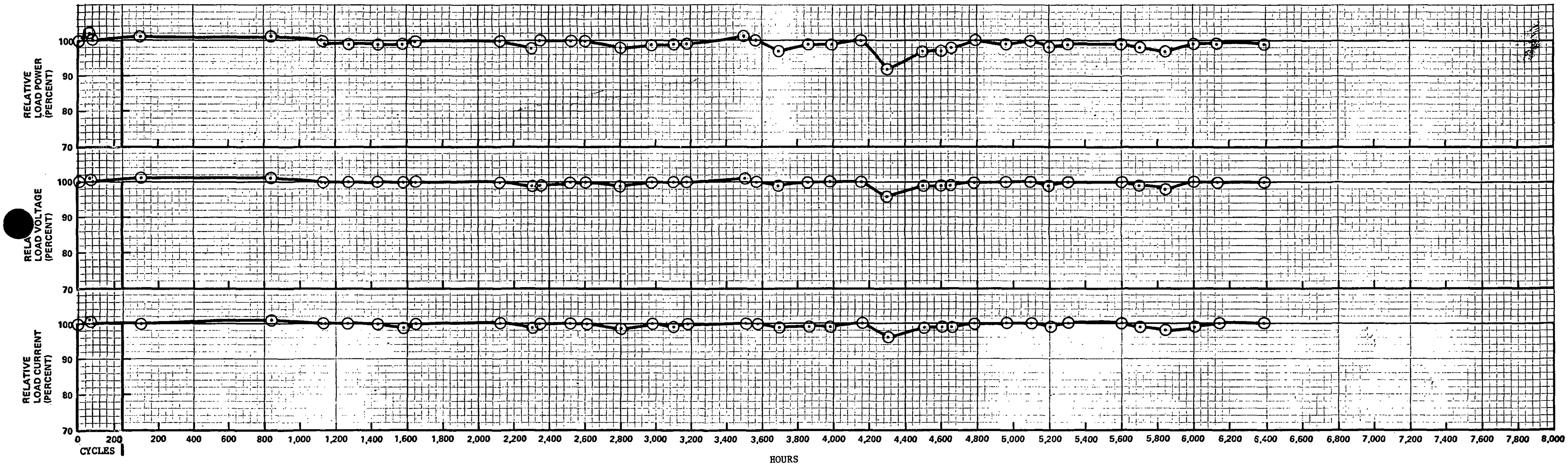

Figure 59 RELATIVE LOAD PERFORMANCE PARAMETERS VS CYCLES AND HOURS FOR CONTROL CELL 45

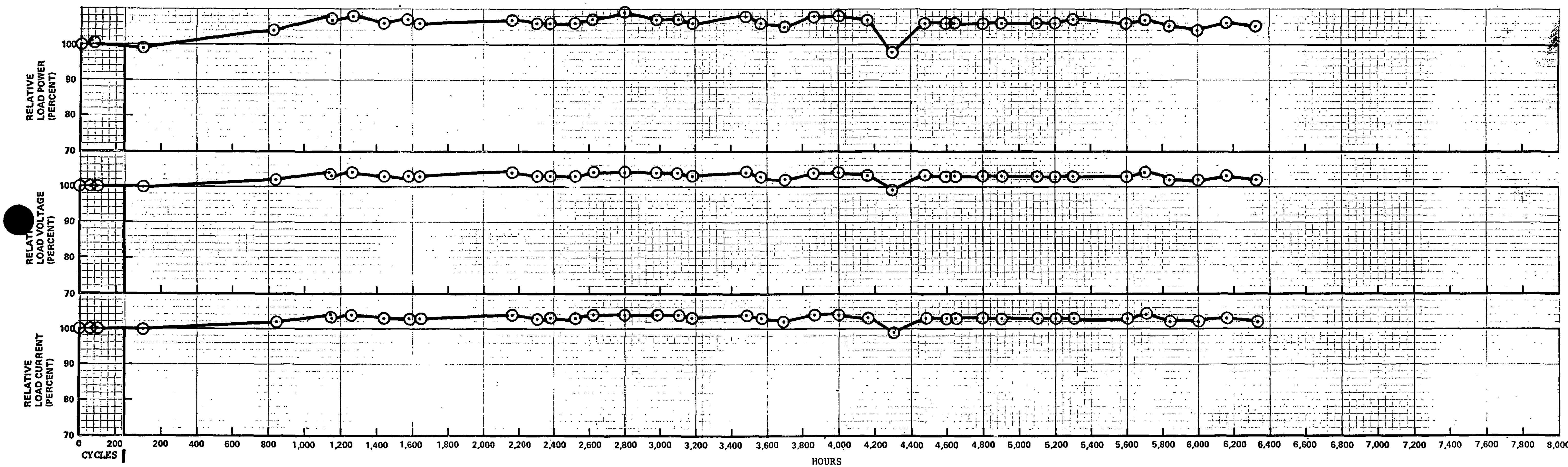

Figure 60 RELATIVE LOAD PERFORMANCE PARAMETERS
VS CYCLES AND HOURS FOR CONTROL CELL 46

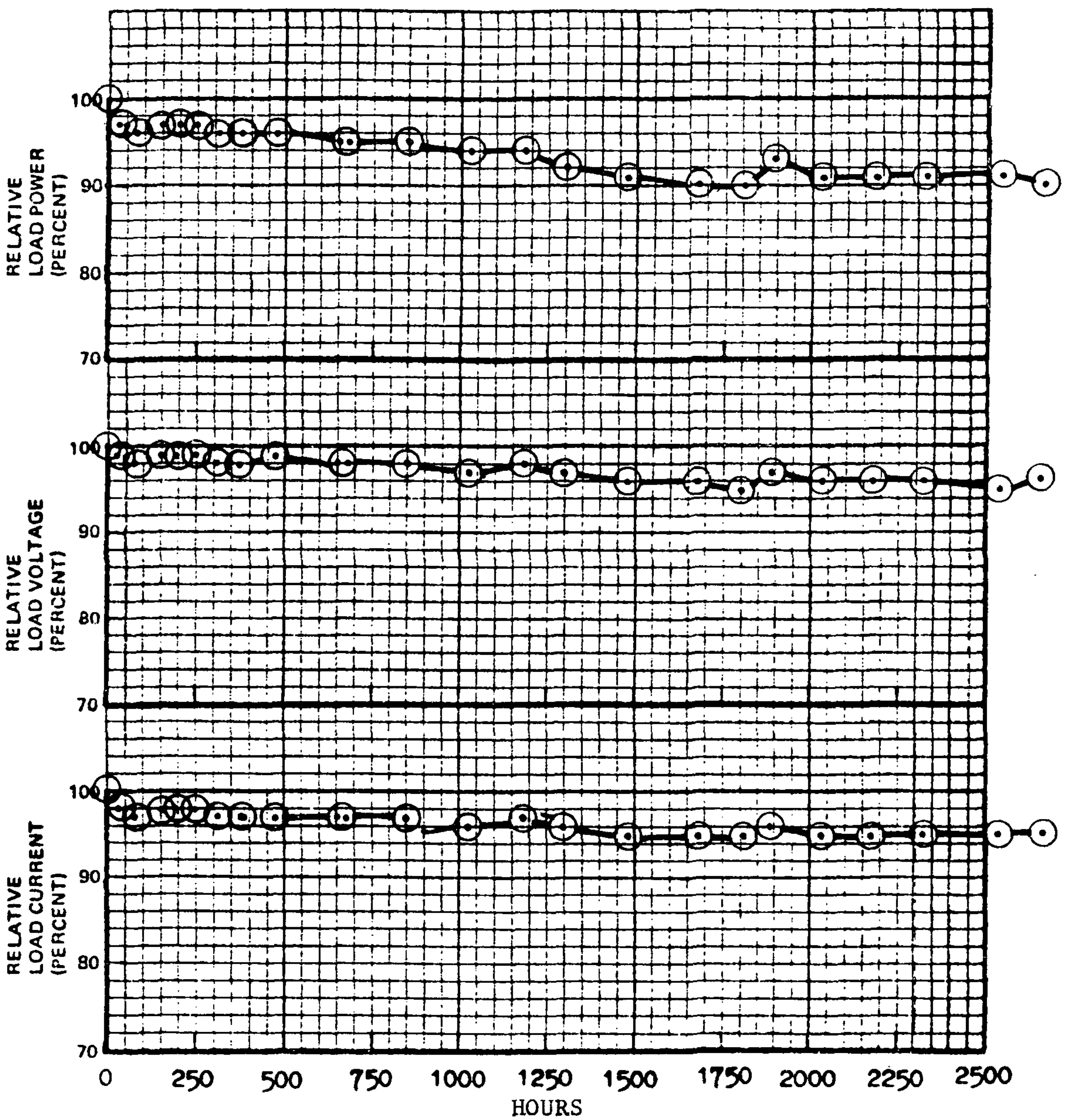

Figure 61: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 47

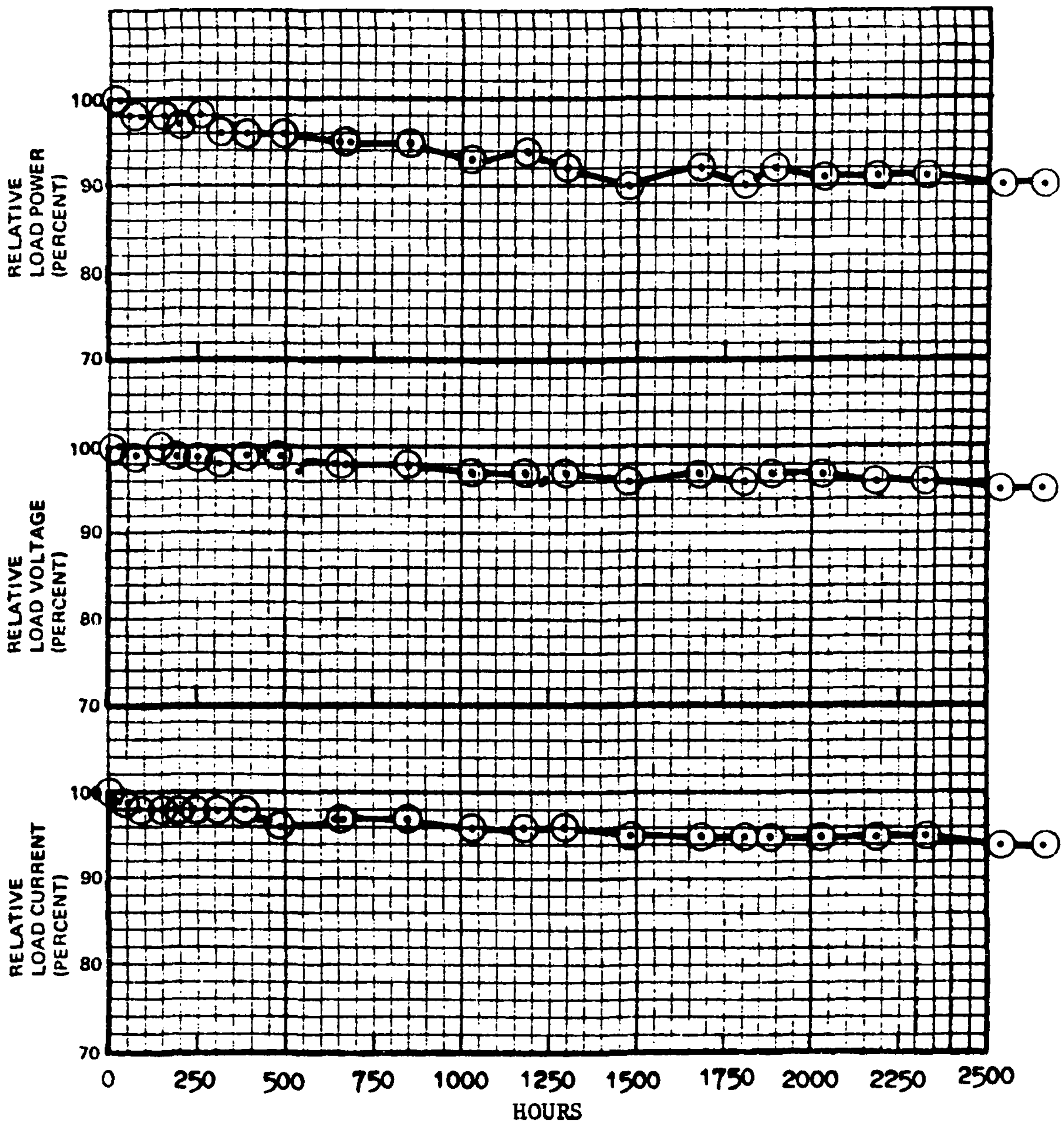

Figure 62: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 48

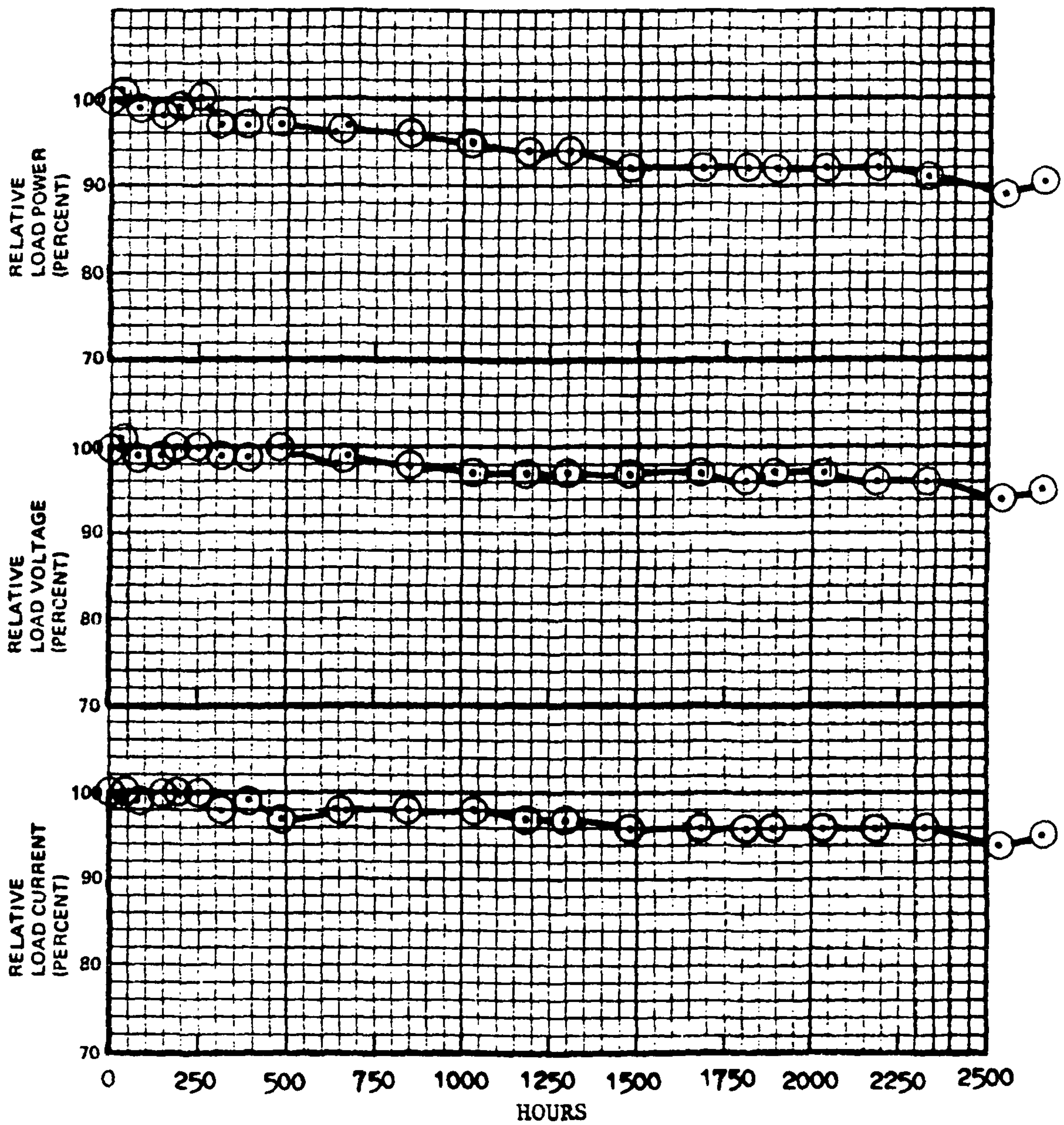

Figure 63: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 49

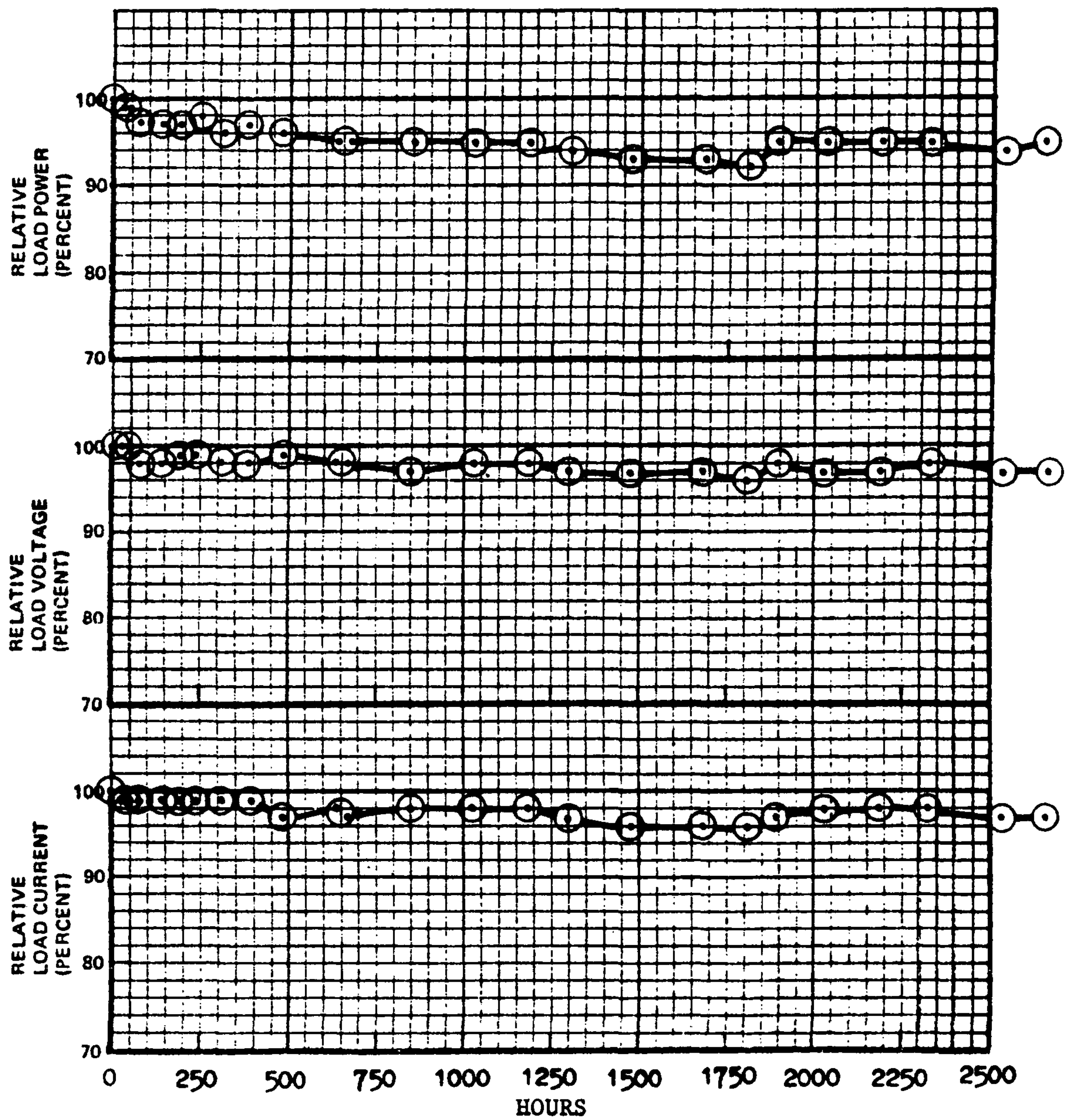

Figure 64: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 50

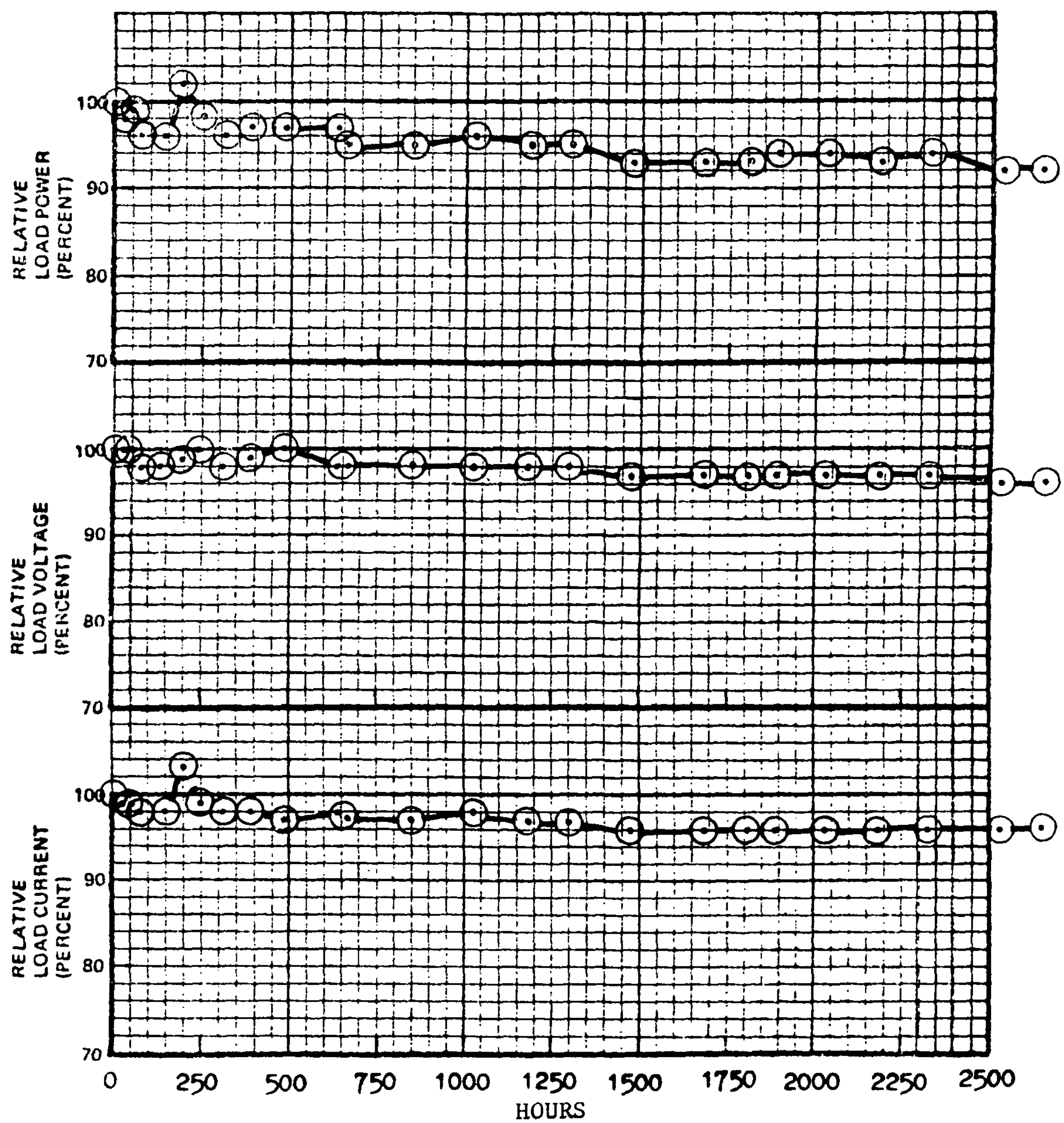

Figure 65: RELATIVE LOAD PERFORMANCE P^RAMETERS VERSUS HOURS FOR TEST CELL NO. 51

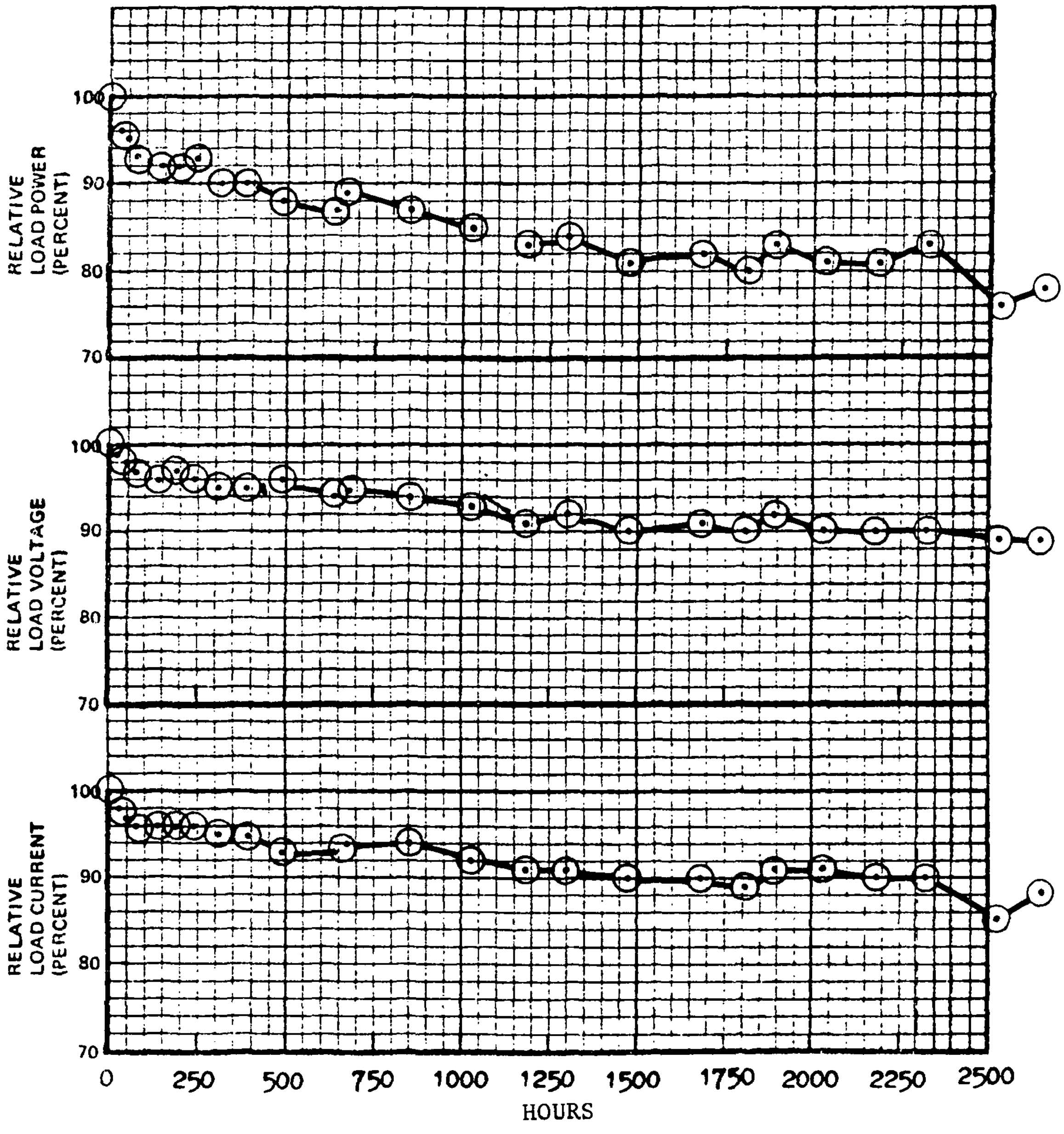

Figure 66: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 52

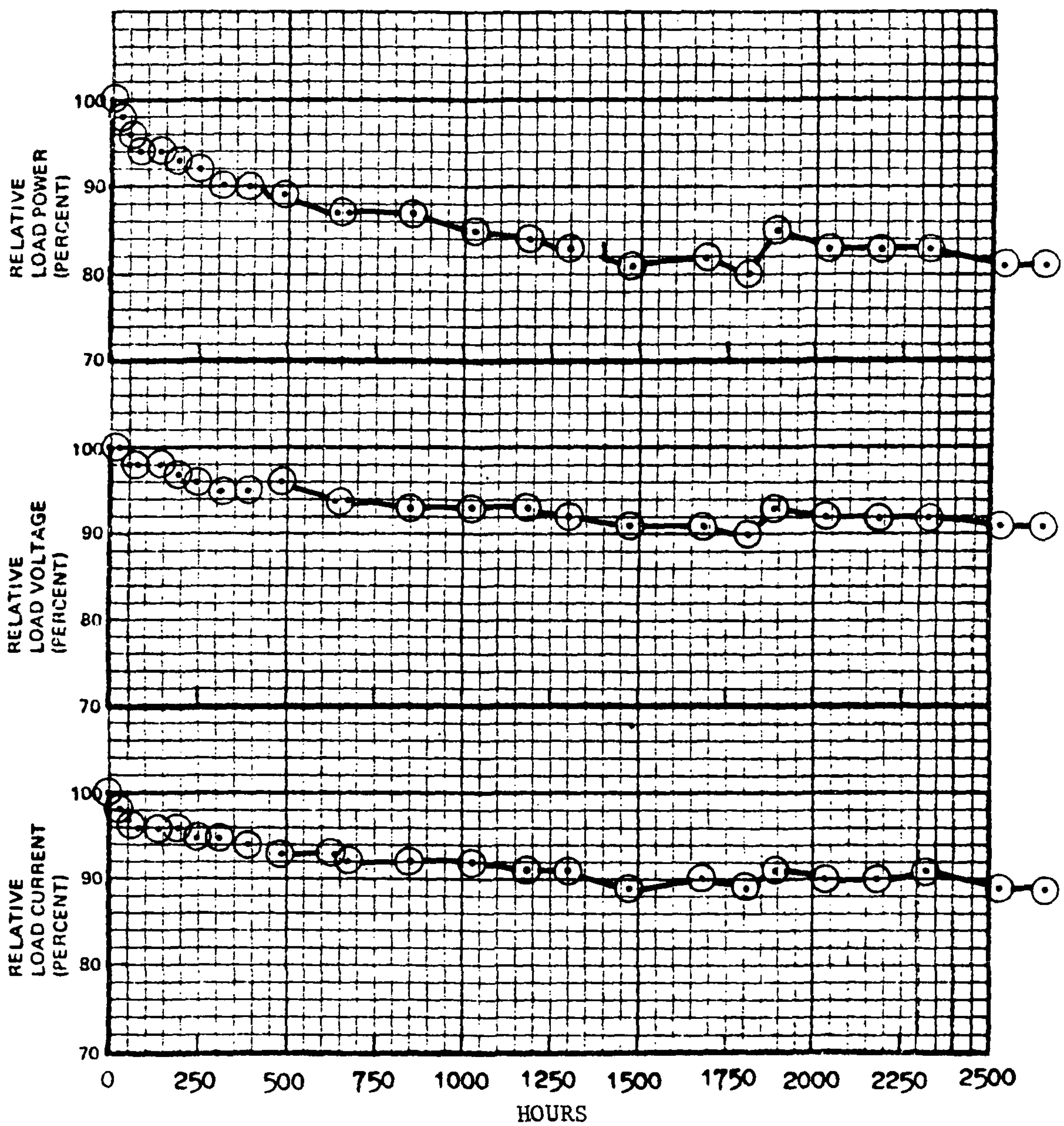

Figure 67: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 53

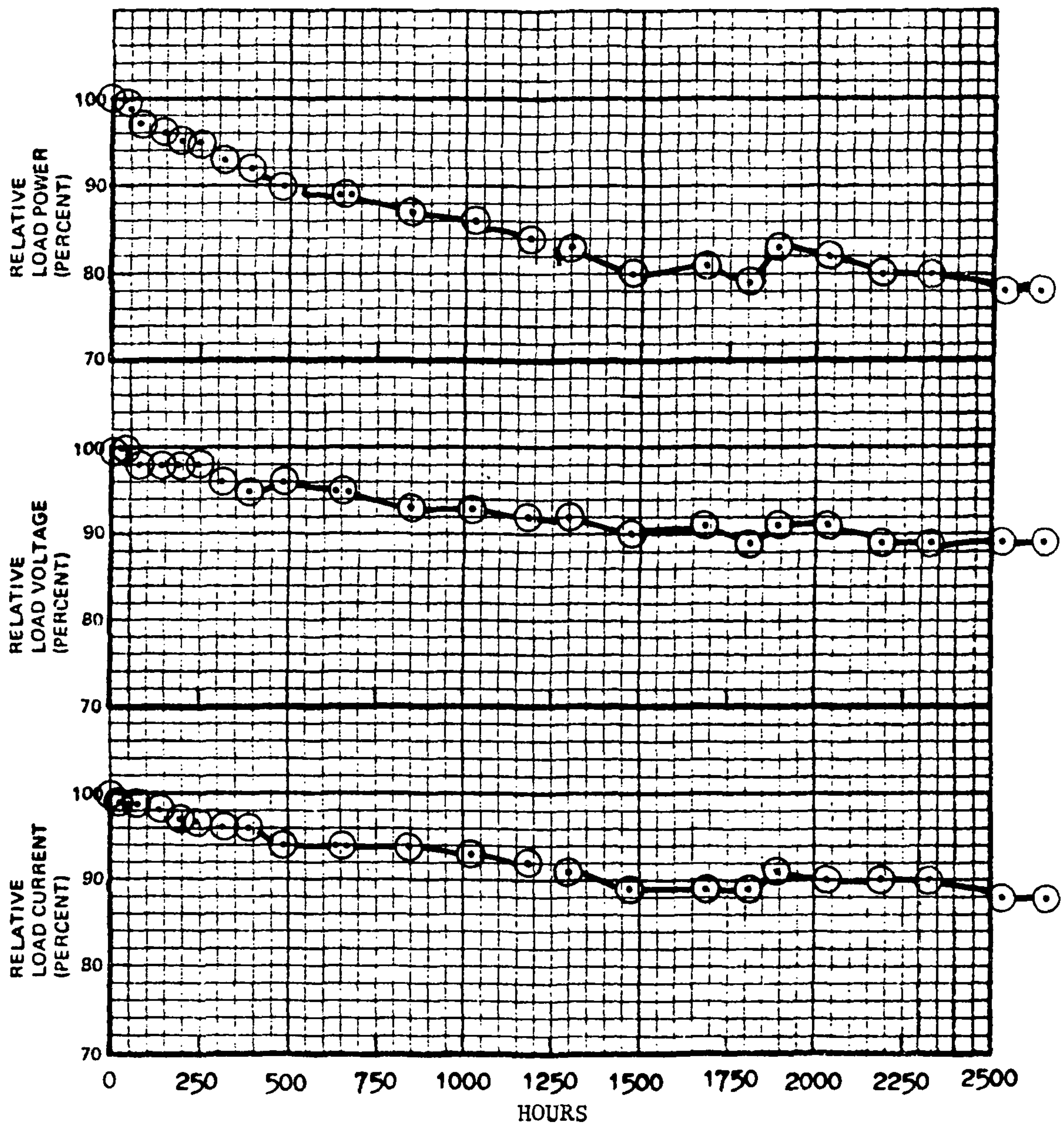

Figure 68: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 54

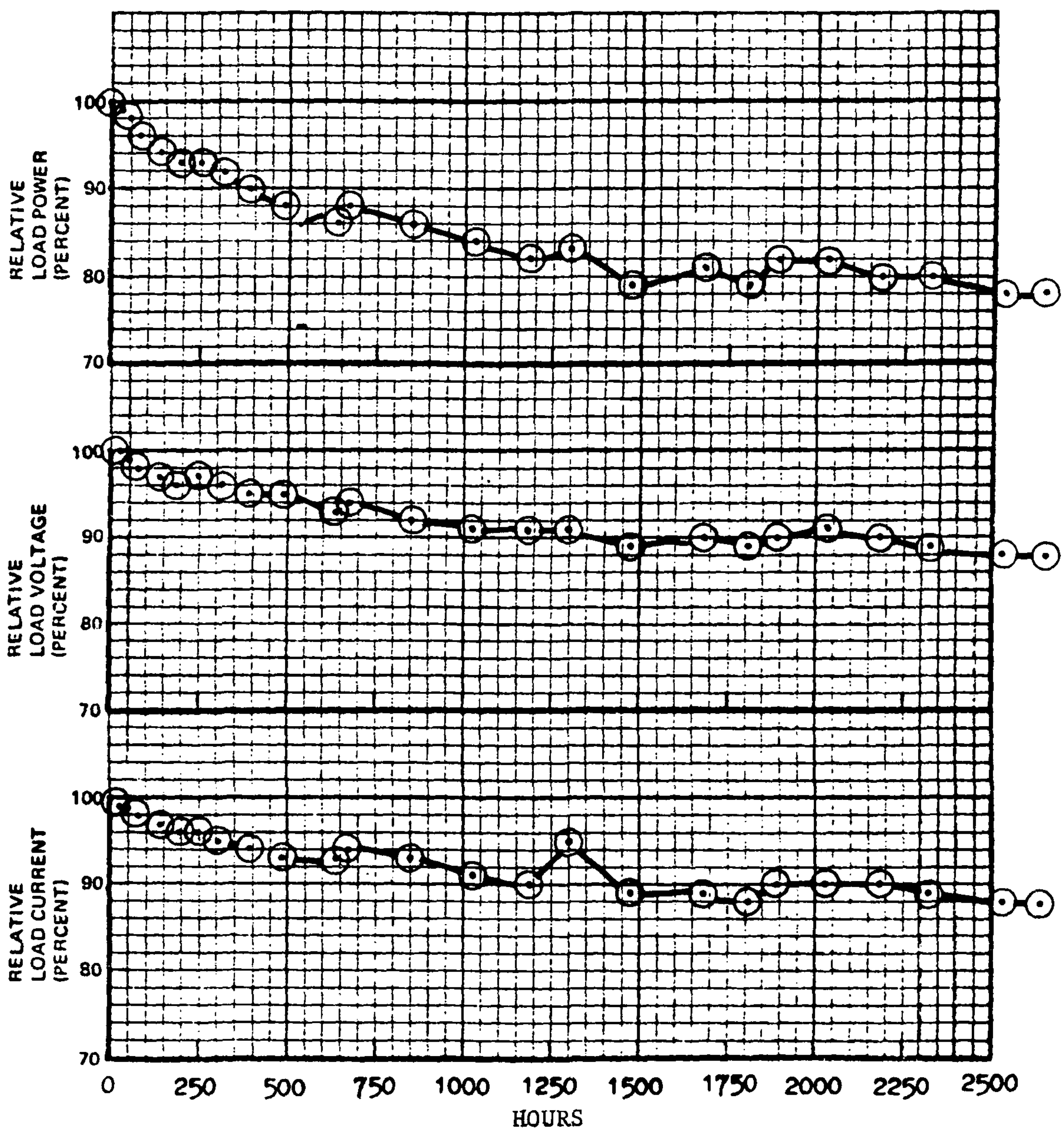

Figure 69: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 55

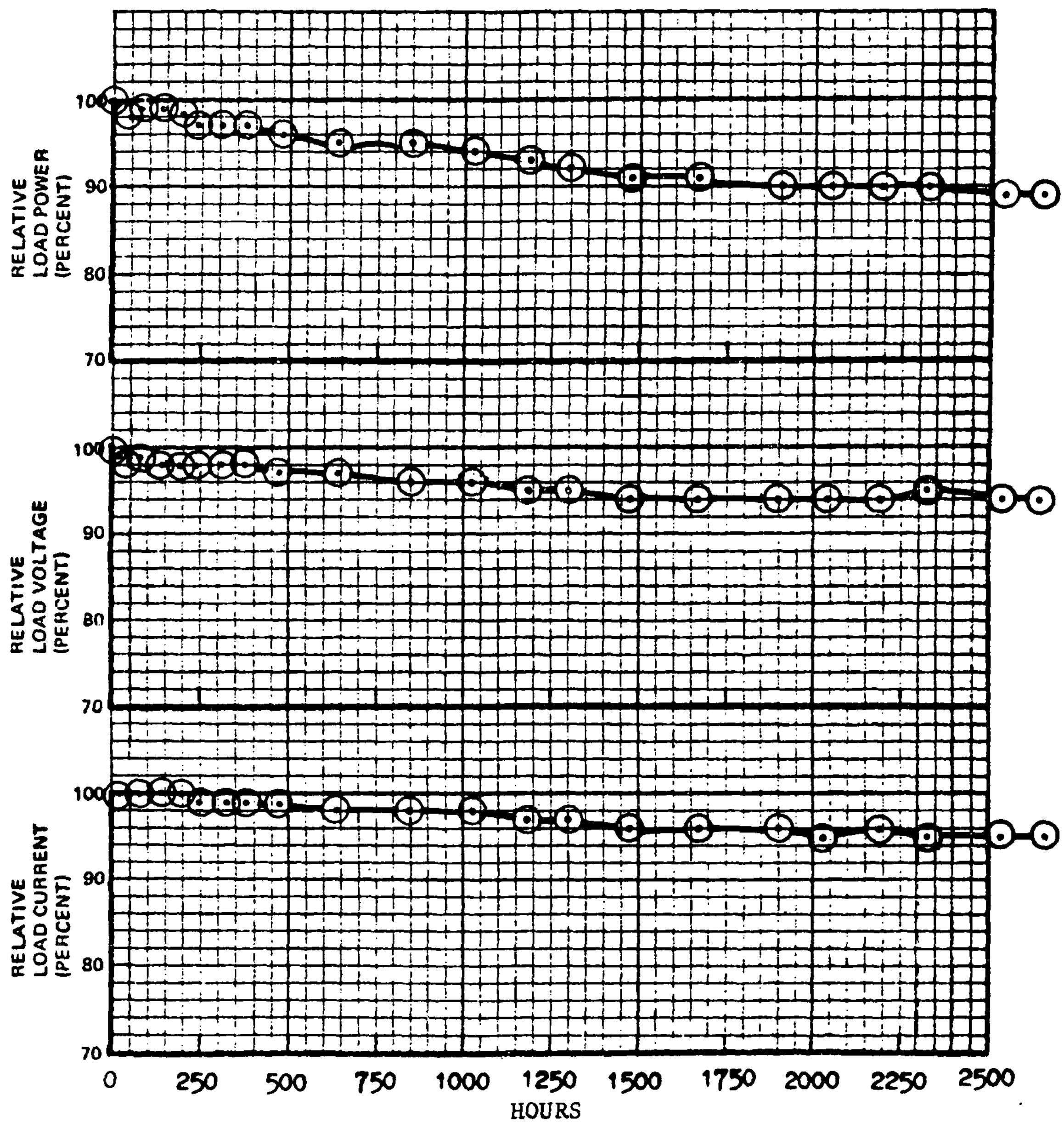

Figure 70: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 56

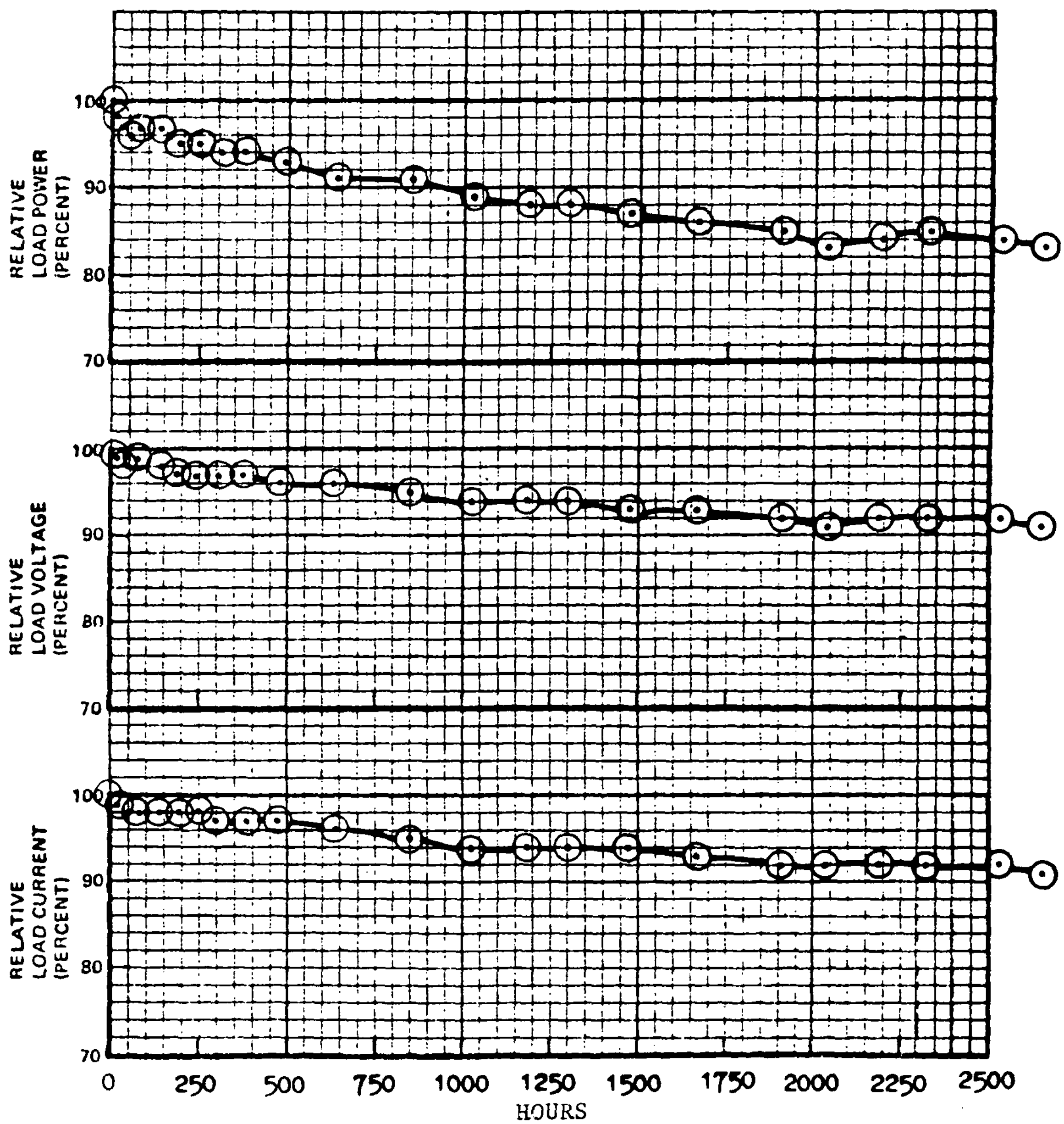

Figure 71: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 57

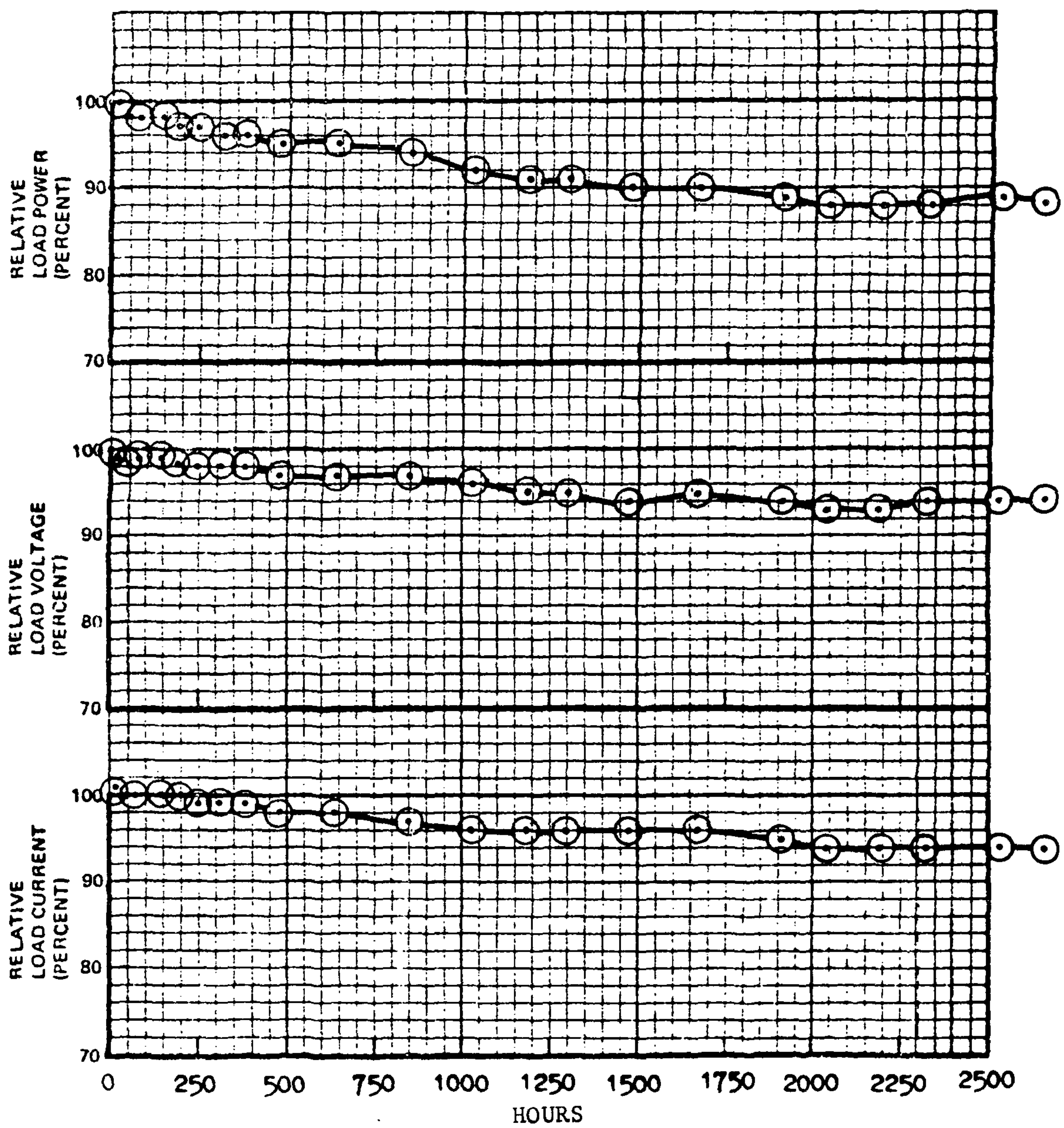

Figure 72: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 58

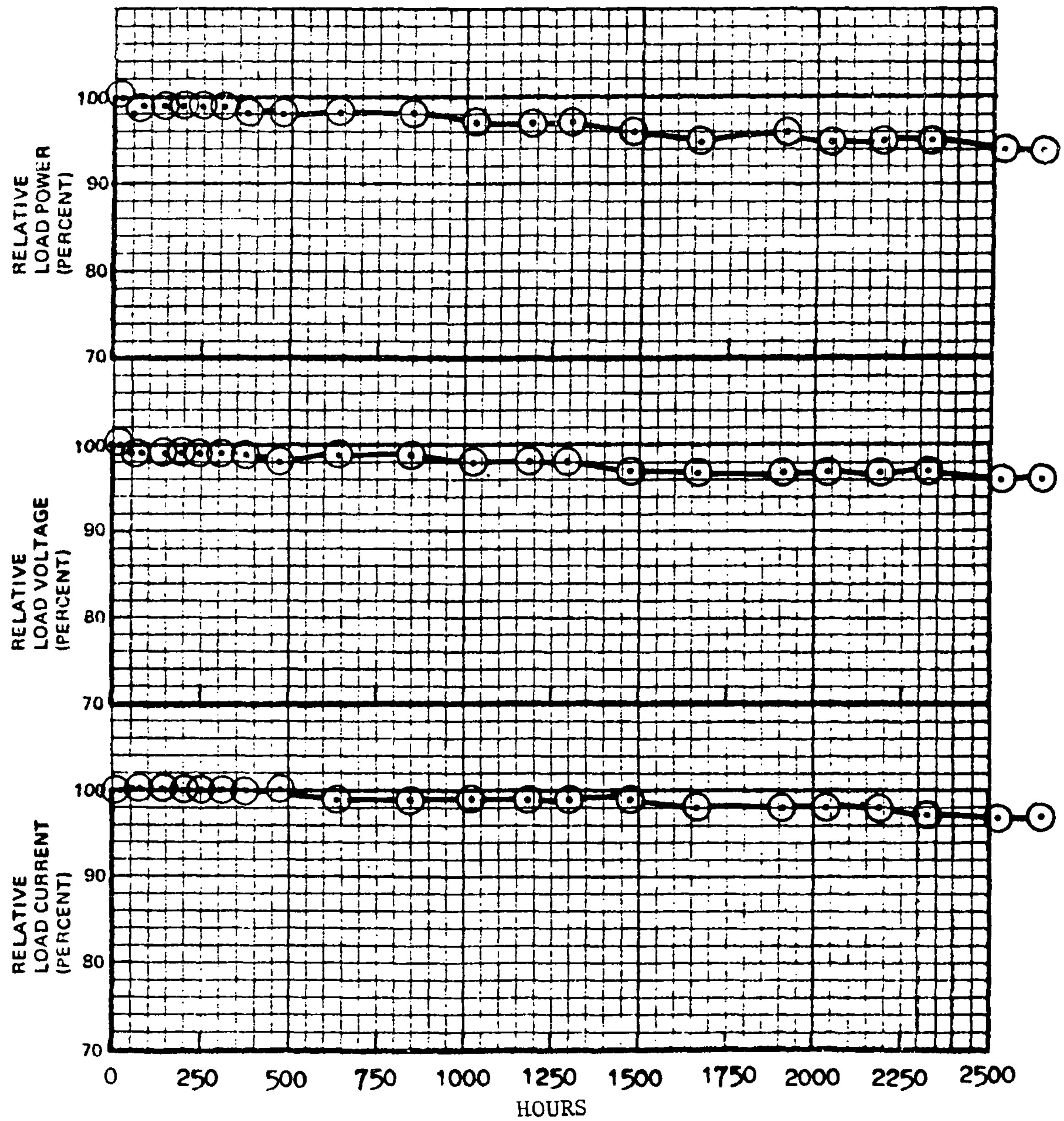

Figure 73: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 59

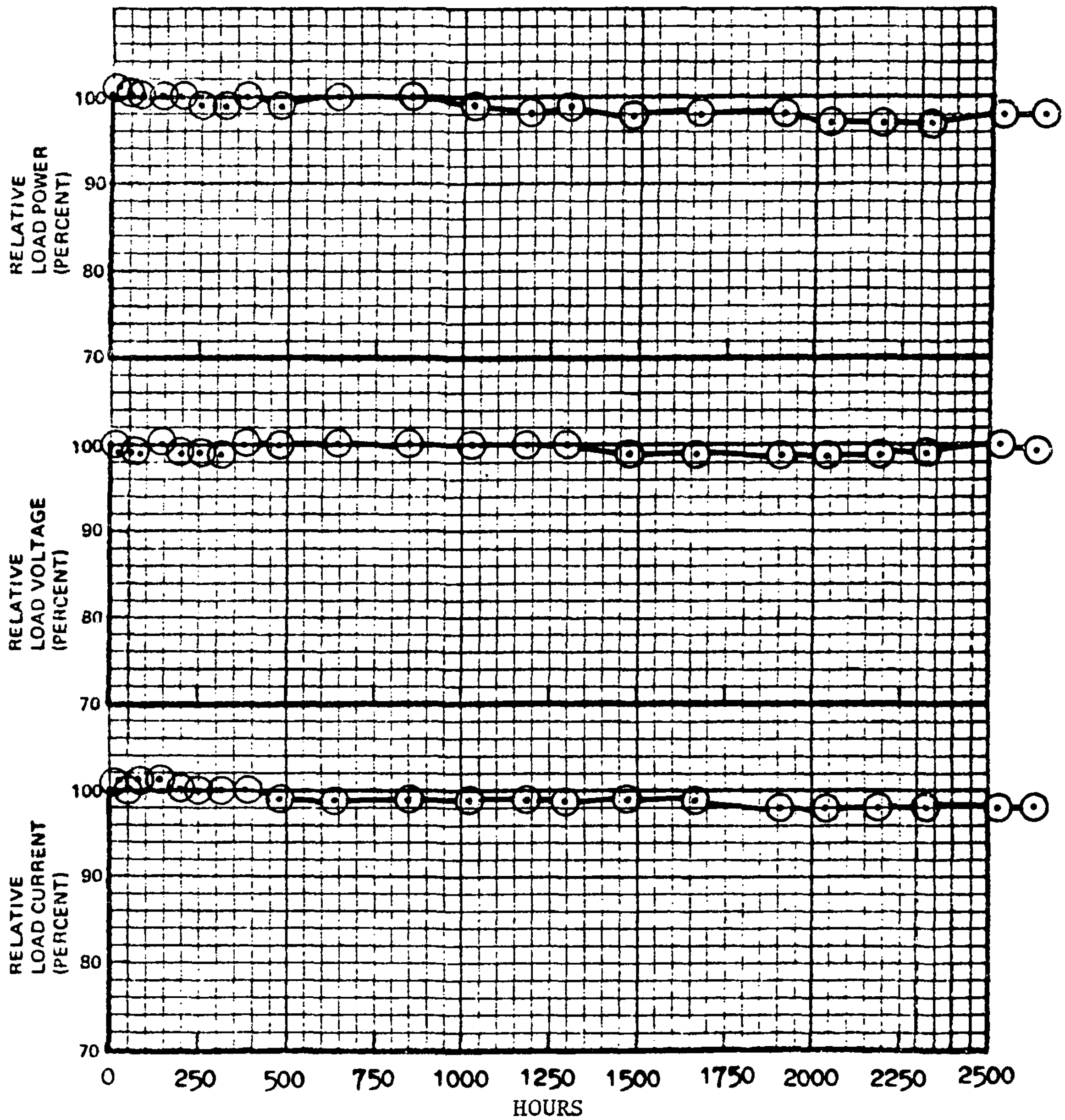

Figure 74: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 60

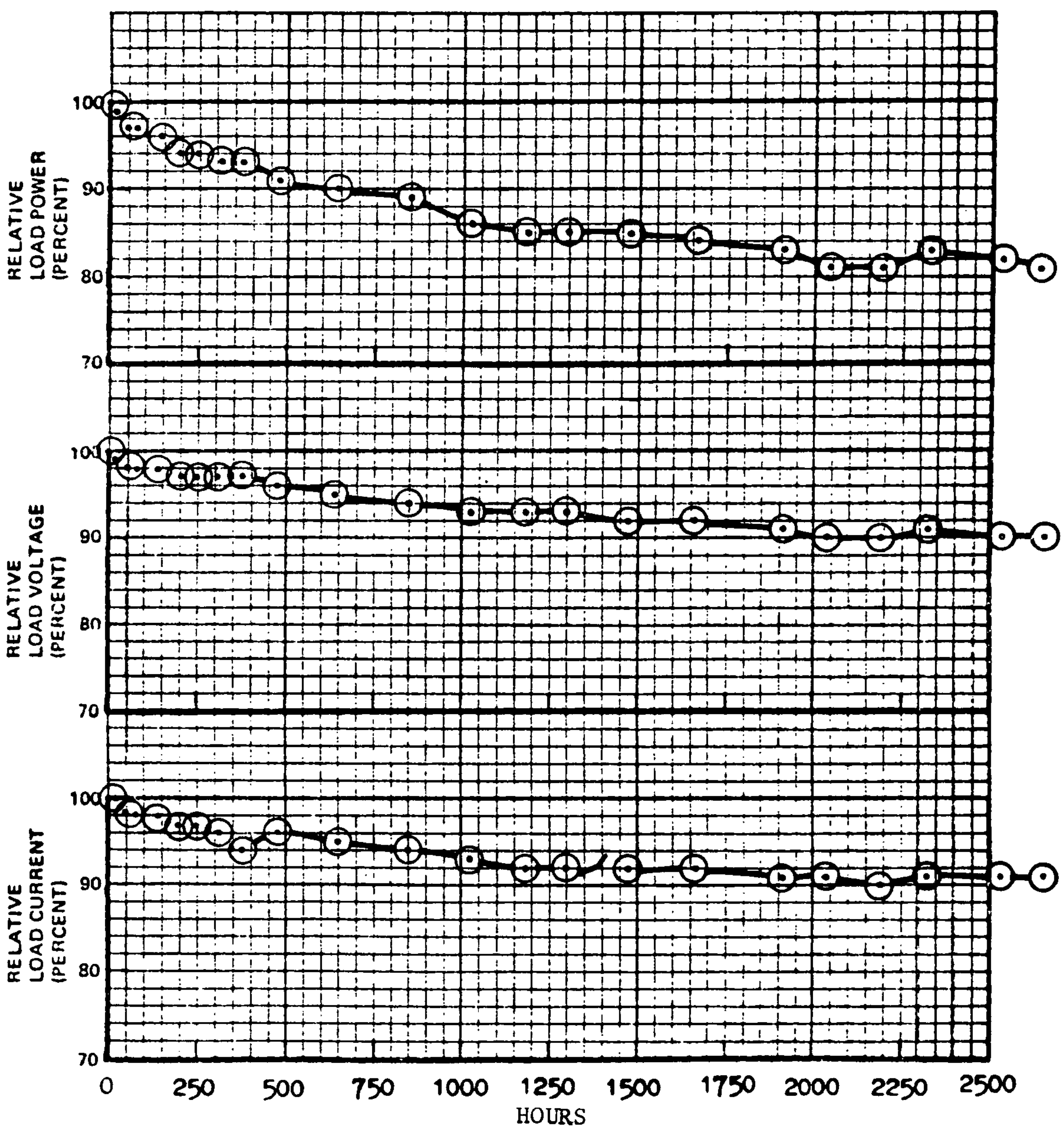

Figure 75: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 61

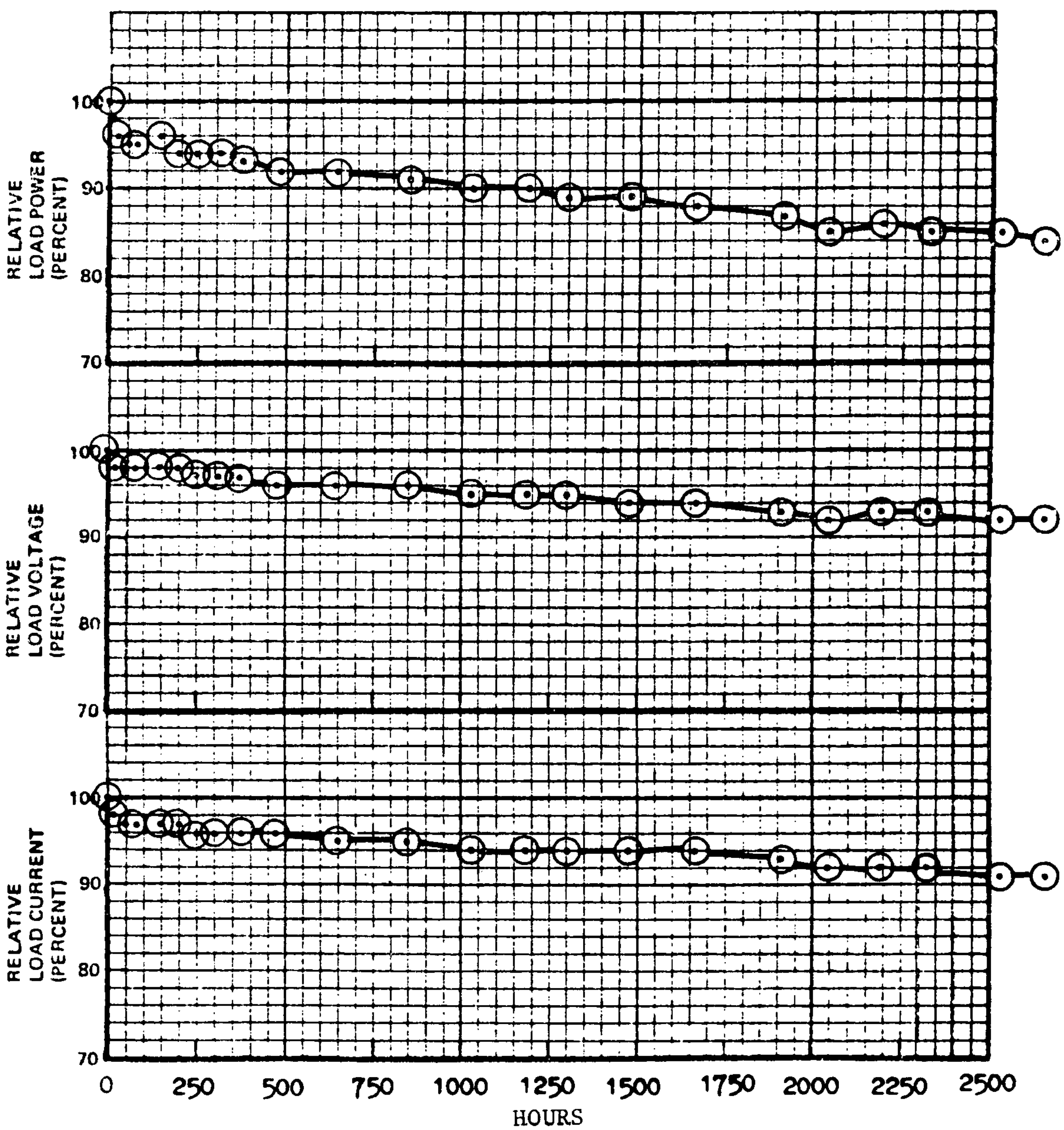

Figure.76: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 62

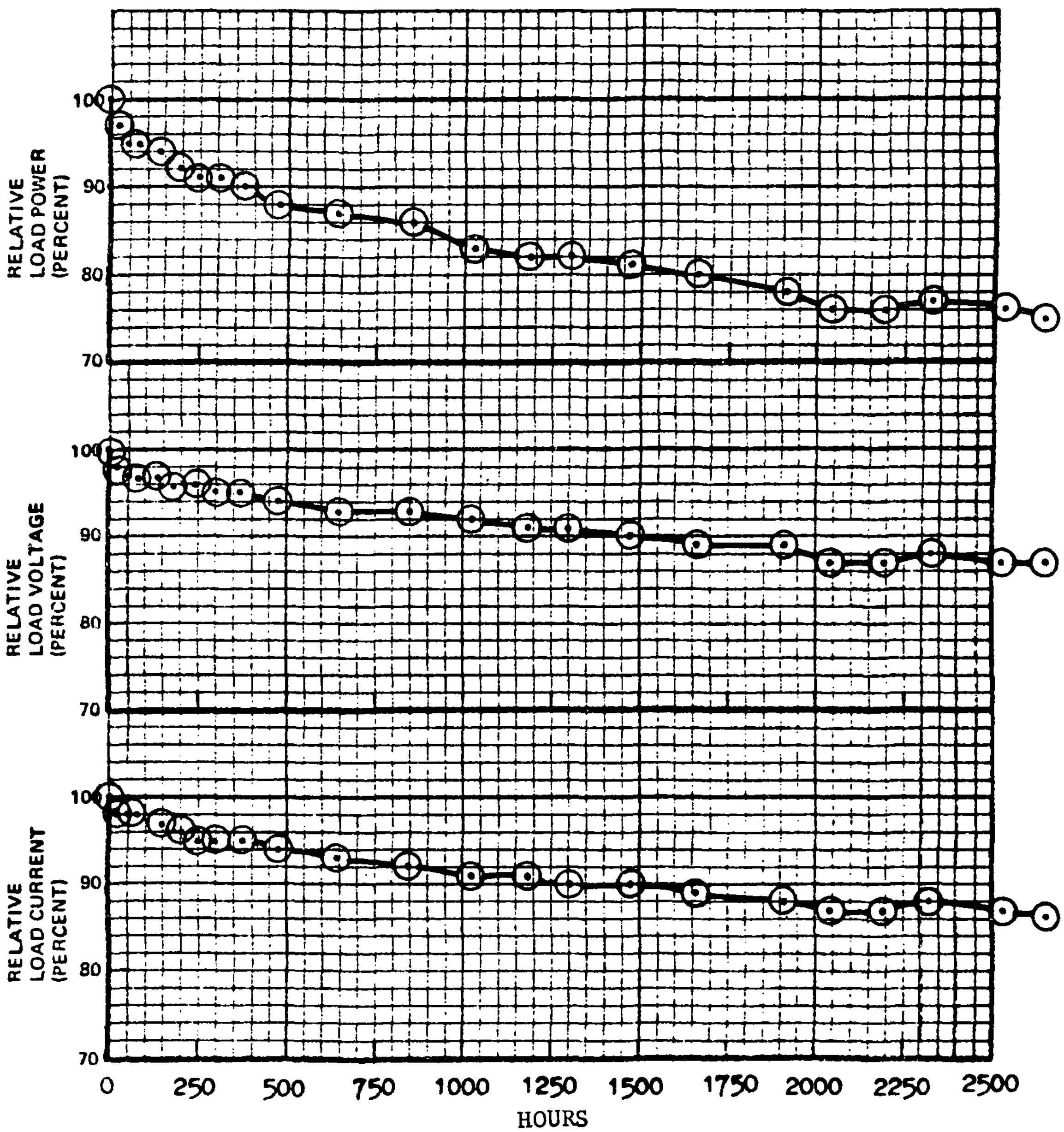

Figure 77: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 63

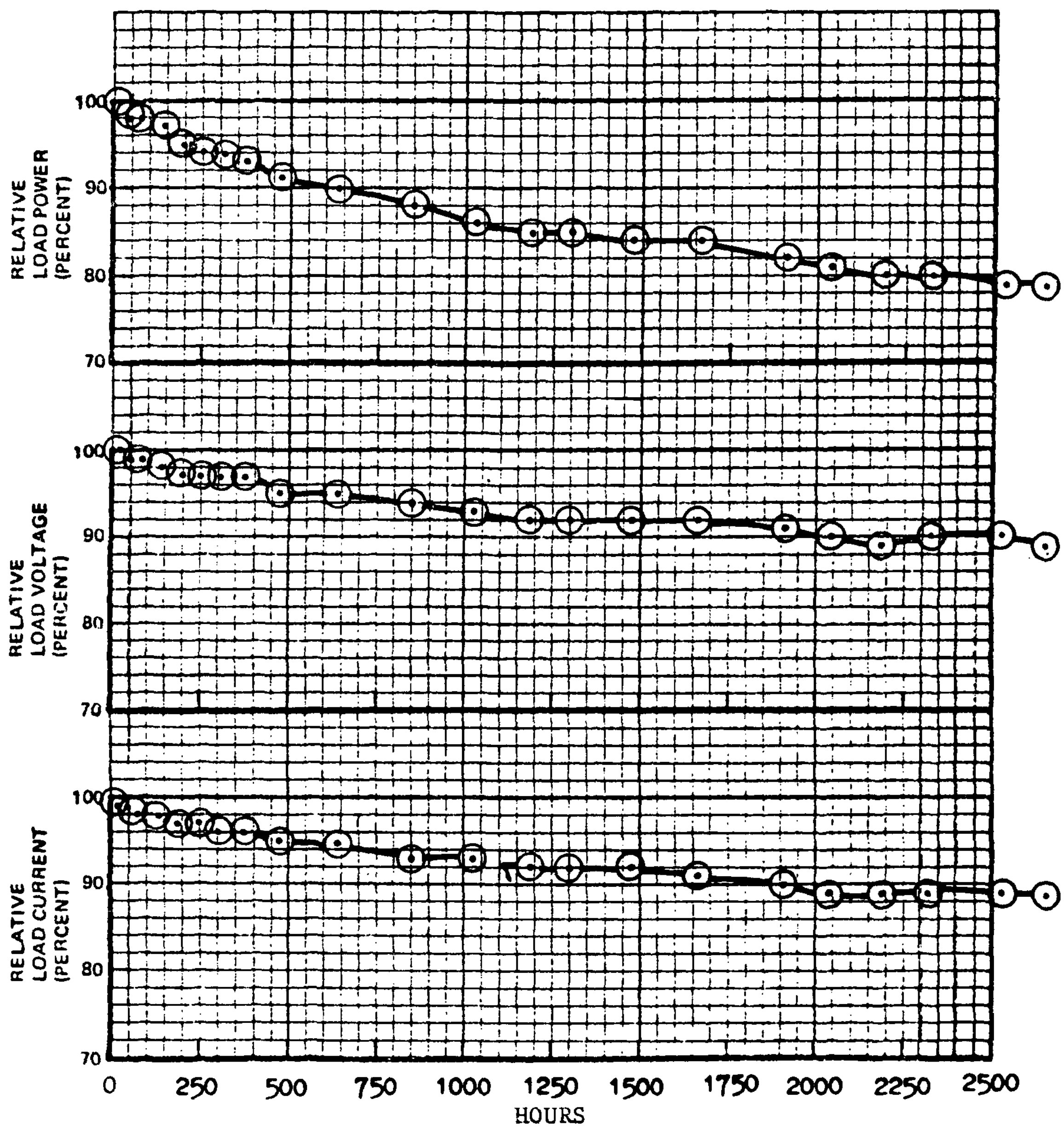

Figure 78: RELATIVE LOAD PERFORMANCE PARAMETERS VERSUS HOURS FOR TEST CELL NO. 64

Table 9: RELATIVE MAXIMUM POWER VERSUS CYCLES FOR GROUP A TEST CELLS AND CONTROL CELLS

	CELL NUMBER	∇4	CYCLE 1 ∇1 (1)	14	18	33	38	50	55	70	82	98	105 (108)	136	157	200	235 (236)	264	274	304 (307)	402 (433)	510*	511 (527)	605 (606)
TEST CELLS ∇2	1	183	100	96	98	96	95	95	98	96	95	95	97	96	96	96	96	95	93	92	90	88	95	95
	2	191	100	102	102	101	100	100	101	100	101	100	100	101	101	98	100	100	98	97	96	92	99	96
	3	180	100	101	100	97	96	94	97	94	93	95	94	92	91	91	90	90	90	87	85	84	87	86
	4	177	100	102	103	103	102	102	105.	104	104	104	106	106	107	107	106	106	106	105	105	103	106	108
	5	184	100	103	104	102	102	104	106	104	103	104	104	104	105	105	104	105	104	104	102	103	102	105
	AVERAGE		100	101	101	100	99	99	101	100	99	100	100	100	100	99	99	99	98	97	96	94	98	98
CONTROL CELLS ∇3	10	265	100										99				101			92	97		98	99
	11	254	100										101				101			102	99		101	100
	12	245	100										102				101			104	102		99	102
	13	223	100										102				101			103	102		102	99
	14	251	100										98				99			101	99		97	101
	AVERAGE		100										100				101			100			99	100
			702 (733)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995* (1995)	1997	2108 (2109)			
TEST CELLS ∇2	1		97	92	92	91	88	86	92	89	88	88	87	84	86	88	87	84	84	85	84			
	2		99	96	93	94	91	92	93	100	95	83	94	93	93	93	93	88	90	93	90			
	3		87	81	81	80	80	79	80	80	83	79	81	79	82	81	79	76	78	81	78			
	4		112	106	106	105	101	102	102	105	104	103	104	103	105	105	105	103	104	104	102			
	5		107	105	104	105	99	100	100	101	101	101	101	102	103	103	103	103	103	101	101			
	AVERAGE		100	96	95	95	92	92	93	95	94	93	93	92	94	94	93	91	92	93	91			
CONTROL CELLS ∇3	10		101	102	115	100	102	100	98	102	103	100	.100		100	98	99	98	97		98			
	11		101	100	102	102	103	102	102	103	103	100	101		100	101	102	99	101		99			
	12		105	102	102	104	104	103	104	106	106	103	103		104	103	101	99	103		101			
	13		102	99	102	102	98	101.	101	105	105	103	104		103	103	103	101	102		100			
	14		101	101	100	101	102	103	101	102	104	101	98		103	102	102	98	101		88			
	AVERAGE		102	101	104	102	102	102	101	104	104	102	101		102	101	101	99	101		99			
TEST CELLS ∇2	1																							
	2																							
	3																							
	4																							
	5																							
	AVERAGE																							
CONTROL CELLS ∇3	10																							
	11																							
	12																							
	13																							
	14																							
	AVERAGE																							

∇1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES

* DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

∇2 CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

∇3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

∇4 ABSOLUTE VALUES IN MILLIWATTS

ALL MAXIMUM POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 10: RELATIVE OPEN-CIRCUIT VOLTAGE VERSUS CYCLES FOR GROUP A TEST CELLS AND CONTROL CELLS

	CELL NUMBER	▽4	CYCLE																					
			1 ▽1 (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235 (236)	264	274	304 (307)	402 (433)	510*	511 (527)	605 (606)
TEST CELLS ▽2	1	0.389	100	100	101	102	101	102	102	102	102	102	102	103	103	104	104	104	104	105	105	106	104	105
	2	0.388	100	101	102	102	101	102	103	102	103	103	102	103	103	103	104	105	104	104	105	105	102	104
	3	0.393	100	101	101	102	101	101	102	102	101	102	102	102	102	103	103	103	102	102	103	104	103	103
	4	0.388	100	101	102	102	102	102	103	102	102	102	102	103	103	103	103	103	103	104	104	105	104	104
	5	0.391	100	100	102	102	102	102	102	102	103	102	102	102	103	103	103	103	103	103	103	105	104	105
	AVERAGE		100	101	102	102	101	102	102	102	102	102	102	103	103	103	103	104	103	104	104	105	104	104
CONTROL CELLS ▽3	10	0.459	100										100				100			98	98		98	98
	11	0.454	100										101				100			101	99		100	100
	12	0.455	100										102				100			101	100		100	100
	13	0.453	100										102				100			102	100		102	99
	14	0.465	100										100				99			101	99		99	99
	AVERAGE		100										101				100			101	99		100	99
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995* (1995)	1997	2108 (2109)			
TEST CELLS ▽2	1		105	104	107	106	107	106	106	106	105	106	106	106	106	106	106	105	107	107	106			
	2		104	105	106	106	106	106	105	109	105	106	107	106	106	106	106	106	106	106	106			
	3		102	103	104	104	105	105	104	104	104	104	105	106	105	105	105	105	106	106	105			
	4		104	104	106	105	104	104	103	105	104	104	104	106	106	105	106	105	106	106	106			
	5		105	105	106	106	105	104	103	104	104	105	105	106	106	106	106	107	106	105	106			
	AVERAGE		104	104	106	105	105	105	104	106	104	105	105	106	106	106	106	106	106	106	106			
CONTROL CELLS ▽3	10		98	99	99	99	100	99	98	100	100	99	99		99	99	98	99	98		99			
	11		100	100	101	101	101	100	100	101	101	100	100		100	100	101	100	100		100			
	12		101	101	101	103	102	101	101	102	103	102	101		101	101	101	101	101		101			
	13		101	98	101	101	98	99	99	102	101	101	101		101	101	101	101	101		100			
	14		100	100	101	101	100	101	100	100	100	100	100		100	100	100	100	100		100			
	AVERAGE		100	100	101	101	100	100	100	101	101	100	100		100	100	100	100	100		100			
TEST CELLS ▽2	1																							
	2																							
	3																							
	4																							
	5																							
	AVERAGE																							
CONTROL CELLS ▽3	10																							
	11																							
	12																							
	13																							
	14																							
	AVERAGE																							

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

▽2 CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

▽4 ABSOLUTE VALUES IN VOLTS

ALL OPEN-CIRCUIT VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 11: RELATIVE SHORT-CIRCUIT CURRENT VERSUS CYCLES FOR GROUP A TEST CELLLS AND CONTROL CELLS

	CELL NUMBER	⚠4	CYCLE																					
			1 ⚠1 (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235 (236)	264	274	304 (307)	402 (433)	510*	511 (527)	605 (606)
TEST CELLS ⚠2	1	813	100	99	98	96	96	95	96	96	95	94	95	94	94	94	93	92	91	89	88	86	92	93
	2	798	100	99	99	98	98	98	99	98	98	98	98	98	99	98	97	97	97	95	94	92	97	96
	3	765	100	100	99	97	97	97	98	97	97	96	97	96	97	95	95	95	93	93	92	90	93	91
	4	740	100	98	99	97	96	96	98	97	97	95	97	97	97	97	97	96	96	95	95	93	96	97
	5	765	100	99	99	97	97	97	100	98	98	98	98	98	98	98	98	97	97	97	95	94	96	95
	AVERAGE		100	99	99	97	97	97	98	97	97	96	97	97	97	96	96	95	95	94	93	91	95	94
CONTROL CELLS ⚠3	10	863	100										100				101			94	101		99	101
	11	845	100										100				101			101	101		99	100
	12	785	100										99				100			101	101		99	100
	13	740	100										100				102			101	101		100	100
	14	793	100										99				100			101	101		99	100
	AVERAGE		100										100				101			100	101		99	100
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995* (1995)	1997	2108 (2109)			
TEST CELLS ⚠2	1		95	92	88	89	86	87	90	89	91	89	90	87	88	89	88	88	86	87	87			
	2		99	96	93	94	92	92	94	95	95	95	96	94	95	94	94	90	92	95	94			
	3		92	92	89	89	86	86	89	90	91	90	90	89	91	90	89	88	87	89	89			
	4		101	96	93	95	91	93	96	95	95	95	96	94	95	95	95	94	94	93	93			
	5		100	95	94	94	92	94	95	94	94	93	94	94	95	94	94	94	94	95	94			
	AVERAGE		97	94	91	92	89	90	93	94	93	92	93	92	93	92	92	91	91	92	91			
CONTROL CELLS ⚠3	10		104	101	101	101	101	100	100	100	101	101	100		101	101	100	100	100		99			
	11		101	100	99	99	100	100	99	100	100	100	100		100	100	99	99	100		99			
	12		103	100	99	99	99	99	99	101	101	100	100		100	100	100	98	100		99			
	13		102	101	99	100	100	100	100	102	101	103	100		100	100	100	100	101		99			
	14		102	100	99	100	100	101	100	101	102	101	101		100	101	100	100	101		100			
	AVERAGE		102	100	99	100	100	100	100	101	101	101	100		100	100	100	99	100		99			
TEST CELLS ⚠2	1																							
	2																							
	3																							
	4																							
	5																							
	AVERAGE																							
CONTROL CELLS ⚠3	10																							
	11																							
	12																							
	13																							
	14																							
	AVERAGE																							

⚠1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.
*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

⚠2 CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

⚠3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

ALL SHORT-CIRCUIT CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

⚠4 ABSOLUTE VALUES IN MILLIAMPERES

Table 12: RELATIVE FILL FACTOR VERSUS CYCLES FOR GROUP A TEST CELLS AND CONTROL CELLS

	CELL NUMBER	(4)	CYCLE (1) 1 (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235 (236)	264	274	304 (307)	402 (433)	510*	511 (527)	605 (606)
TEST CELLS (3)	1	68.0	100	97	99	99	98	98	99	98	98	99	100	98	99	98	100	98	97	98	97	96	99	97
	2	61.7	100	102	101	101	101	101	100	100	100	100	100	100	100	97	100	99	98	99	98	96	98	97
	3	59.8	100	100	99	98	98	97	97	96	95	97	95	93	92	93	92	93	95	91	90	90	91	91
	4	61.8	100	102	103	104	104	104	104	105	104	107	107	106	107	106	106	106	106	106	106	105	105	106
	5	61.5	100	103	103	103	104	106	104	104	103	104	104	104	105	104	103	104	105	103	104	104	102	106
	AVERAGE		100	101	101	101	101	101	101	101	100	101	101	100	101	100	100	100	100	99	99	98	99	99
CONTROL CELLS (3)	10	66.8	100										100				100			100	95		102	100
	11	66.2	100										101				100			100	99		102	100
	12	68.6	100										100				100			102	101		100	102
	13	66.6	100										101				99			100	100		100	100
	14	68.2	100										99				99			100	99		98	102
	AVERAGE		100										100				100			101	100		101	101
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995* (1995)	1997	2108 (2109)			
TEST CELLS (3)	1		97	97	98	96	95	•94	95	94	93	94	91	91	91	93	93	89	92	91	91			
	2		96	96	95	95	94	95	94	97	95	93	92	94	93	94	94	72	92	93	91			
	3		92	87	88	87	89	87	87	86	88	84	85	85	86	86	85	84	85	86	84			
	4		105	106	107	105	106	105	103	106	106	105	104	103	104	105	105	105	104	106	103			
	5		102	105	105	106	103	102	102	103	104	103	102	102	102	104	103	103	104	100	102			
	AVERAGE		98	98	99	98	97	97	96	97	97	96	95	95	95	96	96	95	95	95	94			
CONTROL CELLS (3)	10		100	102	115	101	101	101	101	101	102	100	101		100	99	101	100	100		101			
	11		100	100	102	102	102	102	102	102	101	100	100		100	101	102	100	101		100			
	12		100	102	101	102	103	103	103	103	103	102	102		103	102	101	100	102		100			
	13		100	100	102	101	100	102	102	101	103	101	103		101	101	102	101	100		101			
	14		100	101	100	101	102	101	101	101	102	101	97		102	101	102	99	100		98			
	AVERAGE		100	101	104	101	102	102	102	102	102	101	101		101	101	102	100	101		100			
TEST CELLS (3)	1																							
	2																							
	3																							
	4																							
	5																							
	AVERAGE																							
CONTROL CELLS (3)	10																							
	11																							
	12																							
	13																							
	14																							
	AVERAGE																							

(1) CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.
(2) CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.
*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE
(3) CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.
(4) ABSOLUTE VALUES (PERCENT)

ALL FILL FACTOR VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 13: RELATIVE LOAD POWER VERSUS CYCLES FOR GROUP B TEST CELLS AND CONTROL CELLS

	CELL NUMBER	④	CYCLE 1 ① (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235 (236)	264	274	304 (307)	402 (432)	510*	511 (536)	[illegible]
TEST CELLS ②	5	181	100	98	100	98	98	99	100	99	99	102	103	102	101	102	102	101	101	101	101	97	102	102
	6	198	100	98	98	98	97	97	100	99	99	97	97	97	97	97	99	95	96	95	94	91	92	96
	7	182	100	100	101	100	99	100	107	101	101	102	101	101	101	102	102	101	100	99	99	96	97	101
	8	199	100	99	101	101	101	100	101	101	99	101	101	101	100	99	101	100	106	102	99	101	97	107
	9	192	100	100	101	99	99	98	101	99	101	100	101	101	101	100	100	99	99	100	100	98	98	102
	AVERAGE		100	99	100	99	99	99	102	100	100	100	101	100	100	100	101	99	100	99	99	97	97	102
CONTROL CELLS ③	14	260	100										102				101			101	101		101	102
	15	269	100										99				99			100	97		98	98
	16	231	100										100				101			102	99		98	98
	17	256	100										100				100			101	100		99	99
	18	232	100										98				98			100	99		97	98
	AVERAGE		100										100				100			101	99		99	99
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995* (1995)	1997	2108 (2109)	2124 (2124)	2215 (2216)	2307 (2307)
TEST CELLS ②	5		99	99	98	192	91	93	94	95	96	94	94	95	96	95	96	94	94	95	94	—	—	—
	6		92	94	93	90	100	87	91	89	90	88	88	90	92	90	90	93	90	91	91	92	87	89
	7		97	101	99	99	80	88	88	84	87	86	86	100	97	96	89	97	95	97	90	102	90	96
	8		101	98	99	96	85	91	88	86	87	91	91	102	98	98	99	98	98	100	100	104	95	97
	9		98	101	98	97	85	91	90	88	90	86	88	98	98	97	98	96	97	98	98	98	91	95
	AVERAGE		97	99	97	97	88	90	90	88	90	89	89	97	96	95	94	96	95	96	95	99	91	94
CONTROL CELLS ③	14		102	102	103	102	103	104	103	106	104	103	103		103	103	103	100	102		104	-	-	-
	15		99	100	100	98	98	101	100	101	102	100	102		100	100	100	100	99		102	101	100	100
	16		96	99	100	99	100	104	100	100	102	100	100		100	100	100	99	100		101	101	100	101
	17		97	100	100	99	101	101	100	101	85	99	100		97	99	99	98	100		100	101	100	100
	18		97	97	98	98	99	100	99	101	100	103	99		99	98	98	97	99		99	98	97	98
	AVERAGE		98	100	100	99	100	102	100	102	99	101	101		100	100	100	99	100		101	100	99	100
			2419 (2419)	2528 (2528)	2639 (2639)	2703 (2703)	2798 (2798)	2898 (2898)	2912 (2912)	2990 (2990)	3099 (3099)	3205 (3205)	3300 (3300)	3394* (3394)	3395 (3395)	3504 (3504)	3615 (3615)	3722 (3722)	3851 (3852)	3900 (3901)	4011 (4011)	4106 (4106)	4200 (4201)	
TEST CELLS ②	5		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6		88	89	87	88	89	87	86	84	87	84	84	84	84	84	84	84	84	83	82	82	82	
	7		95	103	94	94	97	93	97	96	97	97	94	94	94	95	93	95	94	93	93	94	94	
	8		97	98	98	97	98	98	98	97	98	96	96	97	97	96	95	97	98	97	96	95	97	
	9		96	95	94	95	96	94	93	92	94	91	91	93	93	92	91	91	91	91	90	90	91	
	AVERAGE		94	96	93	91	95	93	94	92	94	92	91	92	92	92	91	92	92	91	90	90	91	
CONTROL CELLS ③	14		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	15		101	99	100	100	99	101	102	102	101	100	97	100	100	102	100	102	101	98	100	101	102	
	16		99	100	101	101	101	101	101	99	101	101	99	101	100	101	101	101	102	101	101	100	100	
	17		100	100	99	99	99	100	100	100	100	99	99	98	97	97	99	99	99	98	99	99	99	
	18		100	99	97	99	98	98	103	99	98	98	100	98	98	98	98	99	98	99	98	99	98	
	AVERAGE		100	100	99	100	99	100	102	100	100	99	99	99	99	99	99	100	100	99	99	100	100	

① CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

② CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

③ CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

④ ABSOLUTE VALUES IN MILLIWATTS

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 13: (Continued)

	CELL NUMBER	CYCLE [1] 4228	4307 (4307)	4401 (4402)	4499 (4499)	4612 (4612)	4720 (4721)	4787 (4788)	4898 (4899)	4957 (4958)	5005 (5005)	5104 (5104)	5213 (5213)	5295 (5296)	5408 (5408)	5516 (5517)	5611 (5613)	5628 5628	5709 (5709)	5821 (5819)	5932 (5932)	5996 (5996)	6091 (6091)
TEST CELLS [3]	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—					
	6	84	84	83	83	82	86	86	83	84	86	82	84	84	83	82	81	81	82	83	82	82	81
	7	94	95	95	95	95	93	95	92	93	94	93	94	94	94	92	93	91	91	92	93	93	92
	8	96	97	96	96	97	96	98	95	95	97	93	95	104	115	108	107	107	104	100	92	92	92
	9	92	91	92	91	91	91	92	89	90	91	89	90	91	89	88	89	87	88	89	90	89	89
	AVERAGE	92	92	92	91	91	92	93	90	91	92	89	91	93	95	93	93	92	91	91	89	89	89
CONTROL CELLS [3]	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—					
	15		100	102	98	102	98	103	101	102	98	101	101	102	100	100	99	99	103	103	98	102	100
	16		102	101	101	102	100	102	102	101	101	101	101	101	101	103	103	101	101	103	102	103	100
	17		99	100	100	100	100	99	100	99	99	98	99	99	99	99	98	100	100	99	99	100	99
	18		99	99	99	99	99	100	100	100	100	99	101	100	100	101	101	100	100	100	100	101	100
	AVERAGE		100	101	100	101	99	101	101	101	100	100	101	101	100	101	100	100	101	101	100	102	100
		6217 (6217)	6313 (6313)	6408 (6408)	6485 (6485)	6610 (6610)	6638 (6638)	6705 (6706)	6832 (6832)	6927 (6927)	6964 (6965)	6966	6967	6978	6979	7011 (7012)	7108 (7109)	7205 (7205)	7249 (7249)	7347 (7347)	7410 (7410)	7538 (7539)	7621 (7621)
TEST CELLS [2]	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	81	82	82	82	80	84	82	81	80	81	80	81	79	81	85	84	85	82	81	79	77	78
	7	93	91	95	95	93	94	93	93	91	92	91	92	90	90	92	92	93	88	88	88	85	89
	8	92	92	94	95	93	95	93	93	93	92	114	112	103	102	101	100	100	96	96	97	95	95
	9	89	88	89	91	88	91	89	89	88	89	91	92	89	89	92	93	93	85	86	85	82	83
	AVERAGE	89	88	90	91	89	91	89	89	88	89	94	94	90	91	93	92	93	88	88	87	85	86
CONTROL CELLS [3]	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	15	98	99	100	103	99	99	102	101	101	100					100	100	100	97	97	100	98	102
	16	103	103	102	104	102	102	102	101	102	101					101	102	101	95	97	104	101	102
	17	100	99	99	99	99	98	99	96	99	98					98	99	99	98	97	100	98	98
	18	101	100	101	100	100	100	101	99	101	99					99	100	100	101	96	100	102	100
	AVERAGE	101	100	101	102	100	100	101	99	101	100					100	100	100	98	97	101	100	101
		7718 (7718)	7833 (7833)	7945 (7946)	8006 (5882)	8067 (8067)	8180 (8181)	8290 (8291)	8412 (8412)	8514	8622 (8622)	8706 (8707)	8732 (8733)	8831 (8831)	8946 (8946)	9036 (9036)	9100 (9101)	9182 (9182)	9373 (9373)	9436 (9436)	9529 (9530)	9634 (9634)	9737 (9738)
TEST CELLS [2]	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	78	75	74	75	79	78	77	76	74	75	73	78	78	77	76	76	76	75	75	72	75	77
	7	91	88	88	88	86	87	87	88	86	86	84	87	83	84	84	84	84	84	83	82	83	84
	8	96	93	93	95	93	93	94	94	92	93	93	93	93	92	92	93	93	94	95	93	94	92
	9	83	80	81	80	84	84	84	84	81	82	81	83	82	82	82	82	83	82	81	80	81	82
	AVERAGE	87	84	84	85	86	86	86	86	83	84	83	85	84	84	84	84	84	84	84	82	83	84
CONTROL CELLS [3]	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	15	99	95	87	100	99	102	102	100		99	97	98	102	100	101	100	103	100	100	98	99	102
	16	102	99	102	103	101	101	101	102		102	101	102	102	102	101	102	102	101	103	102	102	101
	17	97	95	98	99	102	97	96	102		98	97	98	99	99	99	98	99	99	98	99	97	97
	18	100	99	100	100	99	99	99	100		101	101	100	99	100	99	100	100	100	100	100	100	99
	AVERAGE	100	97	97	102	100	100	100	101		100	99	100	101	100	100	100	101	100	100	100	100	100

[1] CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

[2] CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

[3] CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 13: (Concluded)

	CELL NUMBER	CYCLE ▽1 9861 (9861)	10,047 (10,048)
TEST CELLS ▽2	5	–	–
	6	75	76
	7	86	80
	8	95	89
	9	83	79
	AVERAGE	85	81
CONTROL CELLS ▽3	14	–	–
	15	97	100
	16	102	100
	17	99	97
	18	107	100
	AVERAGE	101	99

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 14: RELATIVE LOAD VOLTAGE VERSUS CYCLES FOR GROUP B TEST CELLS AND CONTROL CELLS

	CELL NUMBER	(4)	CYCLE 1 (1) (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235	264	274	304	402	510	511	606
TEST CELLS (2)	5	0.289	100	99	100	99	99	100	100	100	100	101	102	101	101	101	101	101	101	101	101	99	101	102
	6	0.287	100	99	99	99	99	98	100	100	99	99	99	99	99	99	100	97	98	97	96	96	96	98
	7	0.298	100	100	100	100	100	100	103	100	101	101	101	101	100	101	101	100	100	100	100	98	99	100
	8	0.314	100	100	100	100	101	100	100	100	100	100	100	100	100	100	101	100	103	101	100	100	99	103
	9	0.297	100	100	101	99	100	99	101	100	100	100	100	100	100	100	100	100	100	100	100	99	99	101
	AVERAGE		100	100	100	99	100	99	101	100	100	100	100	100	100	100	101	100	100	100	99	98	98	101
CONTROL CELLS (3)	14	0.366	100										101				101			101	100		100	101
	15	0.371	100										100				100			100	98		99	99
	16	0.344	100										100				100			101	100		99	99
	17	0.382	100										100				100			100	100		100	100
	18	0.348	100										99				99			100	99		98	99
	AVERAGE		100										100				100			100	100		99	100
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995 (1995)	1997	2108 (2109)	2124 (2124)	2215 (2216)	2307 (2307)
TEST CELLS (2)	5		100	100	100	101	96	97	98	98	99	98	98	98	99	98	99	98	98	98	98	—	—	—
	6		96	97	96	95	100	93	96	95	95	94	94	95	96	95	95	97	95	96	96	96	94	95
	7		99	101	99	99	89	94	94	91	93	92	92	100	99	98	95	99	97	95	99	101	96	98
	8		101	99	100	98	92	95	94	93	93	95	95	101	99	99	100	99	100	100	100	107	09	99
	9		99	101	99	98	92	95	95	94	95	93	94	99	99	98	99	98	99	99	99	99	96	97
	AVERAGE		99	100	99	98	94	95	95	94	95	94	95	99	98	98	98	98	98	98	98	100	96	97
CONTROL CELLS (3)	14		101	101	101	101	101	102	101	102	102	101	101		102	101	101	100	101		102	-	-	-
	15		100	100	100	99	99	101	100	100	101	100	101		100	100	100	100	100		101	101	100	100
	16		98	99	100	100	100	102	100	100	101	100	100		100	100	100	99	100		101	101	100	100
	17		99	100	100	100	101	101	100	101	92	100	100		98	100	100	99	100		100	101	100	100
	18		98	99	99	99	99	100	99	101	100	101	99		99	99	99	99	99		99	99	98	99
	AVERAGE		99	100	100	100	100	101	100	101	99	100	100		100	100	100	99	100		101	100	99	100
			2419 (2419)	2528 (2528)	2639 (2639)	2703 (2703)	2798 (2798)	2898 (2898)	2912 (2912)	2990 (2990)	3099 (3099)	3205 (3205)	3300 (3300)	3394* (3394)	3395 (3395)	3504 (3504)	3615 (3615)	3722 (3722)	3851 (3852)	3900 (3901)	4011 (4011)	4106 (4106)	4200 (4201)	
TEST CELLS (2)	5		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6		93	95	94	94	95	94	93	92	94	92	92	92	92	92	92	92	92	91	91	91	91	
	7		97	98	97	97	99	97	98	98	98	98	97	97	97	98	97	97	97	97	97	97	97	
	8		100	100	100	99	100	99	99	99	99	98	98	99	99	98	98	99	99	99	98	98	99	
	9		98	98	97	97	98	97	96	96	97	96	96	96	96	96	95	96	96	96	95	95	95	
	AVERAGE		98	98	97	97	98	97	97	96	97	96	96	96	96	96	96	96	96	96	95	95	96	
CONTROL CELLS (3)	14		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	15		100	100	100	100	100	101	101	101	101	100	98	100	100	101	100	101	100	99	100	101	101	
	16		99	100	101	100	100	101	100	100	101	100	100	100	100	100	101	101	101	101	100	100	100	
	17		100	100	100	100	100	100	100	100	100	100	100	99	99	99	100	100	99	99	99	100	100	
	18		100	99	99	99	99	99	101	99	99	99	100	99	99	99	99	100	99	99	99	100	100	
	AVERAGE		100	100	100	100	100	100	100	100	100	100	99	99	99	100	100	100	100	99	99	100	100	

(1) CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.
(2) CELLS IN VACUUM, DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.
*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

(3) CELLS IN AIR, DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

(4) ABSOLUTE VALUES IN VOLTS

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE - 1 VALUES. LIGHT INTENSITY WAS AMO.

Table 14: (Continued)

	CELL NUMBER	CYCLE ▽1 4228	4307 (4307)	4401 (4402)	4499 (4499)	4612 (4612)	4720 (4721)	4787 (4788)	4898 (4899)	4957 (4958)	5005 (5005)	5104 (5104)	5213 (5213)	5295 (5296)	5408 (5408)	5516 (5517)	5611 (5613)	5628 (5628)	5709 (5709)	5821 5819	5932 (5932)	5996 (5996)	6091 (6091)
TEST CELLS ▽2	5*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	92	92	91	91	91	93	93	91	92	93	91	92	92	91	91	90	90	91	91	91	91	90
	7	97	97	97	97	98	97	98	96	96	97	96	97	97	97	96	96	95	96	92	97	96	96
	8	98	99	98	98	99	98	99	98	98	99	97	98	102	107	104	104	104	102	100	96	96	96
	9	96	99	96	96	96	95	96	95	95	95	94	95	96	95	94	95	93	94	94	95	95	94
	AVERAGE	96	97	96	96	96	96	97	95	95	96	95	96	97	98	96	96	96	96	94	95	95	94
CONTROL CELLS ▽3	14		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
	15		100	101	99	101	99	102	101	101	99	101	101	101	100	100	100	100	102	101	99	101	100
	16		101	101	101	101	100	101	101	101	100	100	100	101	100	101	102	101	100	101	101	102	100
	17		100	100	100	100	100	100	100	100	100	99	100	100	100	100	99	100	100	100	100	100	100
	18		99	99	99	99	99	100	100	100	100	99	101	100	100	100	100	100	100	100	100	101	100
	AVERAGE		100	100	100	100	100	101	101	101	100	100	101	101	100	100	100	100	101	101	100	101	100
		6217 (6217)	6313 (6313)	6408 (6408)	6485 (6485)	6610 (6610)	6638 (6638)	6705 (6706)	6832 (6832)	6927 6927	6964 (6965)	6966	6967	6978	6979	7011 (7012)	7108 (7109)	7205 (7205)	7249 (7249)	7347 (7347)	7410 (7410)	7538 (7539)	7621 (7621)
TEST CELLS ▽2	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	90	91	91	91	90	92	91	90	90	90	90	91	90	90	92	92	92	91	90	89	88	88
	7	96	96	97	97	96	97	97	96	96	96	96	96	95	95	96	96	96	94	94	94	92	94
	8	96	96	97	98	97	98	97	97	97	96	107	106	102	101	100	100	100	98	98	98	98	98
	9	94	94	95	95	94	96	95	95	94	95	95	96	94	95	96	96	96	92	93	92	91	91
	AVERAGE	94	94	95	95	94	96	95	95	94	94	95	97	95	95	96	96	96	94	94	93	92	93
CONTROL CELLS ▽3	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	15	99	100	100	101	100	100	101	101	101	100					100	100	100	98	99	100	99	101
	16	101	101	101	102	101	101	101	101	101	101					101	101	101	97	99	102	100	101
	17	100	100	100	100	100	99	100	98	100	99					99	100	100	99	96	100	99	99
	18	100	100	100	100	100	100	101	99	100	99					99	100	100	100	98	100	101	100
	AVERAGE	100	100	100	101	100	100	100	100	101	100					100	100	100	99	98	101	100	100
		7718 (7718)	7833 (7833)	7945 (7946)	8006 (8006)	8067 (8067)	8180 (8181)	8290 (8291)	8412 (8412)	8514	8622 (8622)	8706 (8707)	8732 (8733)	8831 (8831)	8946 (8946)	9036 (9036)	9100 (9100)	9182 (9182)	9373 (9373)	9436 (9436)	9529 (9530)	9634 (9634)	9737 (9738)
TEST CELLS ▽2	5	–																					
	6	88	87	86	87	89	88	88	87	86	87	85	88	89	87	87	87	87	87	86	85	87	88
	7	95	94	94	94	92	93	93	94	93	93	92	93	91	91	91	92	91	91	91	91	91	92
	8	98	96	96	97	97	97	97	97	96	96	96	96	96	96	96	96	96	97	97	96	97	96
	9	91	90	90	90	92	92	92	92	90	91	90	91	91	91	90	90	91	91	90	90	90	91
	AVERAGE	93	92	92	92	93	93	93	93	91	92	91	92	92	91	91	91	91	92	91	91	91	93
CONTROL CELLS ▽3	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	15	100	98	94	100	100	101	101	100		100	98	99	101	100	101	100	101	100	100	99	100	101
	16	101	99	101	101	100	101	101	102		101	100	101	101	101	101	101	101	101	101	101	101	101
	17	99	97	99	100	101	99	98	102		99	98	99	100	100	100	99	100	100	99	100	99	99
	18	100	99	100	100	99	99	99	100		100	100	100	99	100	99	100	100	100	100	100	100	99
	AVERAGE	100	98	99	100	100	100	100	101		100	99	100	100	100	100	100	100	100	100	100	100	100

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 14: (Concluded)

	CELL NUMBER	CYCLE [1] 9651 (9851)	10,047 (10,048)
TEST CELLS [2]	5	–	–
	6	87	87
	7	93	90
	8	97	94
	9	91	90
	AVERAGE	92	90
CONTROL CELLS [3]	14	–	–
	15	98	100
	16	101	100
	17	100	99
	18	103	100
	AVERAGE	101	100

[1] CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

[2] CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

[3] CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 15: RELATIVE LOAD CURRENT VERSUS CYCLES FOR GROUP B TEST CELLS AND CONTROL CELLS

	CELL NUMBER	▽4	CYCLE																					
			1 ▽1 (1)	14	18	33	38	50	55	70	82	93	105 (108)	136	157	200	235 (236)	244	274	304 (307)	402 (432)	510*	511 (526)	605 (605)
TEST CELLS ▽2	5	625	100	99	100	99	99	100	100	99	99	101	101	101	101	101	101	100	101	100	101	99	101	101
	6	690	100	99	99	99	99	98	100	100	99	99	99	99	99	99	100	97	98	97	97	96	96	98
	7	618	100	100	101	100	100	100	104	101	101	101	101	101	101	101	101	101	100	100	100	98	99	101
	8	635	100	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	103	101	100	100	99	103
	9	645	100	100	101	100	100	99	101	100	100	100	100	100	100	100	100	100	100	100	100	99	99	101
	AVERAGE		100	99	100	100	100	99	101	100	100	100	100	100	100	100	100	100	100	100	100	98	99	101
CONTROL CELLS ▽3	14	686	100										101				101			101	100		100	101
	15	725	100										99				100			100	98		99	99
	16	672	100										100				101			101	100		99	99
	17	669	100										100				100			100	100		100	100
	18	674	100										99				99			100	99		98	99
	AVERAGE		100										100				100			100	100		99	100
			702 (703)	814 (815)	875* (876)	918 (921)	1044* (1045)	1045 (1047)	1107 (1107)	1222 (1222)	1332 (1334)	1456 (1457)	1504 (1504)	1505	1599 (1600)	1712 (1713)	1819 (1819)	1933 (1933)	1995 (1995)	1997	2108 (2109)	2124 (2124)	2215 (2216)	2307 (2307)
TEST CELLS ▽2	5		99	99	98	101	95	96	96	97	98	96	96	97	98	97	97	96	96	97	96	—	—	—
	6		96	97	96	95	99	93	96	95	95	94	94	95	96	95	95	96	94	95	95	96	93	94
	7		99	101	100	100	89	94	94	91	93	92	92	100	99	98	95	99	97	99	95	101	95	98
	8		100	99	99	98	92	95	94	93	93	95	95	101	99	99	99	99	99	100	100	102	97	98
	9		99	101	99	98	92	95	95	94	95	93	94	99	99	98	99	98	99	99	99	99	96	97
	AVERAGE		99	99	98	98	94	95	95	94	95	94	95	98	98	97	97	98	97	98	97	100	95	97
CONTROL CELLS ▽3	14		101	101	101	101	101	102	101	104	102	101	101		102	101	101	100	101		102	-	-	-
	15		100	100	100	99	99	101	100	100	101	100	101		100	100	100	100	99		101	101	100	100
	16		98	99	100	100	100	102	100	100	101	100	100		100	100	100	99	100		101	101	100	100
	17		99	100	100	99	101	101	100	101	93	100	100		98	100	100	99	100		100	101	100	100
	18		98	99	99	99	99	100	99	101	100	101	99		99	99	99	99	99		99	99	98	99
	AVERAGE		99	100	100	100	100	101	100	101	99	100	100		100	100	100	99	100		101	100	99	100
			2419 (2419)	2528 (2528)	2639 (2639)	2703 (2703)	2798 (2798)	2898 (2898)	2912 (2912)	2990 (2990)	3099 (3099)	3205 (3205)	3300 (3300)	3394* (3394)	3395 (3395)	3504 (3504)	3615 (3615)	3722 (3722)	3851 (3852)	3900 (3901)	4011 (4011)	4106 (4106)	4200 (4201)	
TEST CELLS ▽2	5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	6		93	94	93	93	94	93	93	91	93	92	91	91	91	92	92	92	92	91	90	90	90	
	7		97	105	97	97	99	97	98	98	98	98	97	97	97	98	97	97	97	97	97	97	97	
	8		98	99	99	98	99	99	99	98	99	98	98	98	98	98	97	98	99	98	98	97	98	
	9		98	98	97	97	98	97	96	96	97	96	96	96	96	96	95	96	96	96	95	95	95	
	AVERAGE		97	99	97	96	98	97	97	96	97	96	96	96	96	96	95	96	96	96	95	95	95	
CONTROL CELLS ▽3	14		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	15		100	100	100	100	99	101	101	101	100	100	98	100	100	101	100	101	100	99	100	101	101	
	16		99	100	100	100	100	101	100	100	101	100	100	100	100	100	101	100	101	101	100	100	100	
	17		100	100	100	100	100	100	100	100	100	100	100	99	99	99	100	100	99	99	99	100	100	
	18		100	99	99	99	99	99	101	99	99	99	100	99	99	99	99	99	99	99	99	99	99	
	AVERAGE		100	100	100	100	100	100	100	100	100	100	99	99	99	100	100	100	100	99	99	100	100	

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

▽4 ABSOLUTE VALUES IN MILLIAMPERES

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 15: (Continued)

	CELL NUMBER	CYCLE ▽1 4228	4307 (4307)	4401 (4402)	4499 (4499)	4612 (4612)	4720 (4721)	4787 (4788)	4898 (4899)	4957 (4958)	5005 (5005)	5104 (5104)	5213 (5213)	5295 (5296)	5408 (5408)	5516 (5517)	5611 (5613)	5628 (5628)	5709 (5709)	5821 (5819)	5932 (5932)	5996 (5996)	6091 (6091)
TEST CELLS ▽2	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	91	91	91	91	90	92	92	91	92	93	90	92	91	91	90	90	90	90	91	90	90	90
	7	97	97	97	97	98	97	98	96	96	97	96	97	97	97	96	96	95	96	96	97	96	96
	8	98	98	98	98	98	98	99	97	97	98	96	97	102	107	103	103	103	102	100	96	95	95
	9	96	96	96	96	96	95	96	95	95	95	94	95	96	95	94	95	93	94	94	95	95	94
	AVERAGE	96	96	96	96	96	96	96	95	95	96	94	95	97	98	96	96	95	96	95	95	94	94
CONTROL CELLS ▽3	14		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—					
	15		100	101	99	101	99	102	101	101	99	101	100	101	100	100	100	100	102	101	99	101	100
	16		101	100	101	101	100	101	101	101	100	100	100	101	100	101	102	101	100	101	101	102	100
	17		100	100	100	100	100	100	100	100	100	99	100	100	100	100	99	100	100	100	100	100	100
	18		99	99	99	99	99	100	100	100	100	93	100	100	100	100	100	100	100	100	100	101	100
	AVERAGE		100	100	100	100	100	101	101	101	100	98	100	101	100	100	100	100	101	101	100	101	100
		6217 (6217)	6313 (6313)	6408 (6408)	6485 (6485)	6610 (6610)	6638 (6638)	6705 (6706)	6832 (6832)	6927 (6927)	6964 (6965)	6966	6967	6978	6979	7011 (7012)	7108 (7109)	7205 (7205)	7249 (7249)	7347 (7347)	7410 (7410)	7538 (7539)	7621 (7621)
TEST CELLS ▽2	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	90	90	90	90	89	91	90	90	89	90	89	90	88	90	92	92	92	91	90	89	88	88
	7	96	96	97	97	96	97	97	96	96	96	95	96	95	95	96	96	96	94	94	94	92	94
	8	95	96	97	97	96	97	96	96	96	96	107	107	101	101	100	100	100	98	98	98	98	98
	9	94	94	95	95	94	96	95	95	94	95	95	96	94	95	96	96	97	92	93	92	91	91
	AVERAGE	94	94	95	95	94	95	95	94	94	94	97	97	95	95	96	96	96	94	94	93	92	93
CONTROL CELLS ▽3	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—*
	15	99	99	100	101	100	99	101	100	101	100					100	100	100	98	99	100	99	101
	16	101	101	101	102	101	101	101	101	101	101					101	101	100	97	99	102	100	101
	17	100	100	99	100	100	99	100	98	100	99					99	100	100	99	96	100	99	99
	18	100	100	100	100	100	100	101	99	100	99					99	100	100	100	98	100	101	100
	AVERAGE	100	100	100	101	100	100	101	100	101	100					100	100	100	99	98	101	100	100
		7718 (7718)	7833 (7833)	7945 (7946)	8006 (8006)	8067 (8067)	8180 (8181)	8290 (8291)	8412 (8412)	8514	8622 (8622)	8706 (8707)	8732 (8733)	8831 (8831)	8946 (8946)	9036 (9036)	9100 (9100)	9182 (9182)	9373 (9373)	9436 (9436)	9529 (9530)	9634 (9634)	9737 (9738)
TEST CELLS ▽2	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	88	87	86	87	89	88	88	87	86	87	85	88	89	88	87	87	87	87	87	85	87	88
	7	95	93	93	94	93	93	93	94	92	93	92	93	91	91	91	92	91	91	91	91	91	91
	8	98	96	96	97	97	96	97	97	96	96	96	96	96	96	96	96	96	97	97	96	97	96
	9	91	90	90	90	92	92	92	92	90	91	90	91	91	91	90	91	91	91	90	90	90	91
	AVERAGE	93	92	92	92	93	92	92	93	94	92	91	92	92	92	91	92	92	92	91	91	91	92
CONTROL CELLS ▽3	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	15	99	98	94	100	100	101	101	100		99	98	99	101	100	100	100	101	100	100	99	99	101
	16	101	99	101	101	100	101	101	101		101	100	101	101	101	101	101	101	101	101	101	101	101
	17	99	97	99	100	101	99	98	101		99	98	99	100	100	100	99	100	99	99	100	99	99
	18	100	99	100	100	99	99	99	100		100	100	100	99	100	99	100	100	100	100	100	100	99
	AVERAGE	100	98	99	101	100	100	100	101		100	99	100	100	100	100	100	100	100	100	100	100	100

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 15: (Concluded)

	CELL NUMBER	CYCLE ① 9851 (9851)*	10,047 (10,048)
TEST CELLS ②	5	–	–
	6	86	87
	7	93	90
	8	97	94
	9	91	89
	AVERAGE	92	90
CONTROL CELLS ③	14	–	–
	15	98	100
	16	101	100
	17	100	99
	18	103	100
	AVERAGE	101	100

① CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESES.

② CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

③ CELLS IN AIR: DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

*DATA OBTAINED JUST PRIOR TO AN X-25L LAMP CHANGE.

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

Table 16: RELATIVE LOAD POWER VERSUS CYCLES FOR GROUP C TEST CELLS AND CONTROL CELLS

	CELL NUMBER	(4)	CYCLE (1)																					
			1 (1)	13	18	33	77	81	91 (92)	105	136 (136)	183 (183)	216 (217)	247 (247)	295 (295)	404 (404)	515 (515)	579 (579)	674 (674)	774 (774)	788 (788)	866 (866)	975 (975)	1081 (1081)
TEST CELLS (2)	19	172	100	99	99	100	99	99	95	96	97	97	97	95	96	97	95	95	95	94	95	95	96	95
	20	177	100	100	108	100	99	100	95	97	97	97	97	95	96	97	95	95	95	95	95	93	94	92
	21	187	100	99	99	96	95	96	92	94	95	95	96	96	95	95	93	94	93	93	91	91	92	89
	22	199	100	100	99	100	100	100	96	97	99	99	99	99	97	99	98	99	99	99	99	99	100	97
	23	212	100	100	99	100	100	100	95	97	98	98	99	97	96	100	97	99	97	98	97	96	98	96
	AVERAGE		100	100	101	99	99	99	95	96	97	97	98	96	96	98	96	96	96	96	95	95	96	94
CONTROL CELLS (3)	24	255	100						102		101	102	102	102	103	102	102	101	102	100	99	102	99	101
	25	245	100						92		94	91	99	95	95	95	96	95	96	97	96	94	96	95
	26	245	100						97		96	96	96	94	96	96	96	96	95	96	96	95	96	95
	27	249	100						98		101	102	101	101	98	102	101	101	102	101	97	99	99	97
	28	315	100						99		101	99	99	98	98	100	98	98	101	99	98	98	100	98
	AVERAGE		100						98		99	98	99	98	98	99	99	98	99	99	97	98	98	97
			1176 (1176)	1270* (1270)	1271 (1271)	1380 (1380)	1491 (1491)	1598 (1598)	1727 (1728)	1776 (1777)	1887 (1887)	1982 (1982)	2076 (2077)	2104	2183 (2183)	2277 (2278)	2375 (2375)	2488 (2488)	2596 (2597)	2663 (2664)	2774 (2775)	2833 (2834)	2881 (2881)	2980 (2980)
TEST CELLS (2)	19		92	93	93	93	92	93	91	90	90	90	90	90	90	90	89	89	88	90	88	89	89	88
	20		91	91	91	92	91	91	90	89	89	89	89	89	90	89	88	89	88	89	86	88	88	86
	21		87	88	88	89	89	89	88	86	86	86	86	86	86	86	86	86	85	86	83	85	86	84
	22		97	99	99	97	98	98	98	99	97	97	98	97	97	98	98	99	99	99	96	97	98	96
	23		95	96	96	95	95	95	95	95	96	95	95	94	95	94	95	95	93	94	93	93	93	91
	AVERAGE		92	93	93	93	93	93	92	92	92	91	92	91	92	91	91	92	91	92	89	90	91	89
CONTROL CELLS (3)	24		101	101	98	102	99	102	103	104	102	102	102		102	103	102	102	102	103	99	98	101	101
	25		98	97	95	95	96	97	96	98	97	95	96		99	97	97	98	96	96	95	97	97	96
	26		96	95	96	94	96	96	95	96	96	96	93		95	95	96	95	95	96	96	95	98	95
	27		101	99	98	101	99	99	98	102	98	102	102		101	99	103	103	100	103	101	100	101	98
	28		97	101	99	98	99	98	99	99	99	100	97		98	100	98	99	99	100	95	99	98	100
	AVERAGE		99	99	97	98	98	98	98	100	98	99	98		99	99	99	99	98	100	97	98	99	98
			3089 (3089)	3171 (3172)	3284 (3284)	3392 (3393)	3487 (3489)	3504 (3504)	3585 (3585)	3697 (3695)	3808 (3808)	3872 (3872)	3967 (3967)	4093 (4093)	4188 (4188)	4284 (4284)	4361 (4361)	4486 (4486)	4514 (4514)	4581 (4582)	4708 (4708)	4803 (4803)	4840 (4841)	
TEST CELLS (2)	19		88	88	87	87	86	83	84	84	84	84	84	83	83	84	84	83	85	84	83	83	83	
	20		88	86	86	86	85	82	84	84	84	84	83	83	82	82	82	81	84	83	82	81	82	
	21		85	85	83	82	82	82	82	83	82	81	82	80	81	82	82	80	83	82	82	80	81	
	22		99	98	99	99	98	92	94	96	94	96	96	96	95	97	96	96	96	96	96	96	96	
	23		93	96	97	95	95	90	91	91	90	91	91	91	89	91	92	91	93	91	93	93	93	
	AVERAGE		91	91	90	90	89	86	87	88	87	87	87	87	86	87	87	86	88	87	87	87	87	
CONTROL CELLS (3)	24		102	102	103	104	102	102	101	103	101	103	98	101	102	101	102	103	102	103	102	102	101	
	25		98	95	98	97	96	97	96	98	96	98	99	95	97	97	98	97	96	97	97	98	97	
	26		95	95	96	95	94	94	95	95	94	97	93	97	97	97	95	94	95	93	94	93	94	
	27		102	102	100	102	101	99	101	102	102	105	99	101	101	101	101	103	99	101	102	100	98	
	28		98	97	99	99	99	98	98	100	100	99	98	100	100	98	98	100	98	97	97	99	100	
	AVERAGE		99	98	99	99	98	98	98	100	99	100	97	99	99	99	99	99	98	98	98	98	98	

(1) CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS

(2) CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C

(3) CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C

(4) ABSOLUTE VALUES IN MILLIWATTS

*DATA OBTAINED JUST PRIOR TO A X-25L LAMP CHANGE

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO

Table 16: (Continued)

	CELL NUMBER	CYCLE ▽1 4842	4843	4854	4855	4887 (4888)	4984 (4985)	5081 (5081)	5125 (5125)	5223 (5223)	5286 (5286)	5414 (5415)	5497 (5497)	5594 (5594)	5709 (5709)	5821 (58[illegible])	5882 (5882)	5943 (5943)	6056 (6057)	6166 (6167)	6288 (6288)	6390	6499 (6499)
TEST CELLS ▽2	19	83	84	82	86	88	88	87	86	85	84	80	82	80	80	78	78	82	81	81	81	80	80
	20	88	89	88	92	95	96	94	93	93	92	88	88	87	84	83	84	85	86	86	86	83	82
	21	84	84	83	87	88	88	88	82	82	80	76	78	76	75	72	73	80	78	76	75	72	74
	22	98	98	95	97	99	100	100	99	100	99	97	98	99	98	98	99	95	97	97	97	95	96
	23	100	101	98	101	103	102	102	102	100	99	98	98	98	96	95	96	95	96	96	96	93	94
	AVERAGE	91	91	89	93	95	95	95	92	92	91	88	89	88	87	85	86	87	88	87	87	85	85
CONTROL CELLS ▽3	24					101	100	103	103	101	103	102	103	103	101	100	102	102	101	102	102		101
	25					96	98	98	97	93	95	95	96	96	94	96	94	95	95	95	96		96
	26					92	93	94	95	92	96	95	95	92	93	95	94	91	95	93	95		93
	27					108	98	99	100	101	99	100	102	98	99	99	100	102	100	98	100		101
	28					85	98	100	99	97	99	99	98	95	98	97	99	98	97	99	99		98
	AVERAGE					96	97	99	99	97	98	98	99	97	97	97	98	98	99	97	98		98

	CELL NUMBER	6582 (6583)	6608 (6609)	6707 (6707)	6822 (6822)	6912 (6912)	6976 (69[illegible]7)	7058 (7058)	7249 (7249)	7312 (7312)	7405 (7406)	7510 (7510)	7613 (7614)	7727 (7727)	7923 (7924)
TEST CELLS ▽2	19	77	81	80	79	77	77	79	76	76	74	76	80	80	75
	20	81	86	87	84	82	82	83	80	80	77	78	85	84	94
	21	70	79	78	76	74	74	74	72	71	69	71	76	76	71
	22	95	95	93	95	94	95	95	94	95	93	95	95	96	91
	23	92	96	96	93	94	93	93	93	92	91	92	94	88	92
	AVERAGE	83	87	87	85	84	84	85	83	83	81	82	86	85	85
CONTROL CELLS ▽3	24	102	102	102	99	103	102	105	100	99	99	99	101	101	100
	25	97	95	97	96	96	97	97	93	97	97	95	95	98	94
	26	93	95	95	93	94	90	94	93	94	94	95	91	96	93
	27	98	99	101	102	100	99	101	99	99	99	98	97	102	100
	28	99	97	100	101	99	99	100	97	98	99	100	96	98	99
	AVERAGE	98	98	99	98	98	97	99	96	97	98	97	96	99	97

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

* DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

Table 17: RELATIVE LOAD VOLTAGE VERSUS CYCLES FOR GROUP C TEST CELLS AND CONTROL CELLS

	CELL NUMBER	▽4	CYCLE ▽1																					
			1 (1)	13	18	33	77	81	91 (92)	105	136 (136)	183 (183)	216 (217)	247 (247)	295 (295)	404 (404)	515 (515)	579 (579)	674 (674)	774 (774)	788 (788)	866 (866)	975 (975)	1081 (1081)
TEST CELLS ▽2	19	0.276	100	100	99	100	99	99	98	98	99	99	99	98	98	98	98	97	97	97	98	97	98	97
	20	0.317	100	100	104	100	99	100	97	98	99	99	99	98	98	98	97	98	98	97	97	97	97	96
	21	0.308	100	100	100	98	98	98	96	97	98	98	98	98	98	98	97	97	97	97	96	96	96	95
	22	0.303	100	100	99	100	100	100	98	98	99	99	99	99	99	100	99	99	99	100	100	99	100	99
	23	0.298	100	100	100	100	100	100	98	99	99	99	100	99	99	100	99	100	99	99	99	98	99	98
	AVERAGE		100	100	100	100	99	99	97	98	99	99	99	98	98	99	98	98	98	98	98	97	98	97
CONTROL CELLS ▽3	24	0.356	100						101		101	101	101	101	101	101	101	101	101	100	99	101	100	101
	25	0.383	100						96		97	95	100	98	98	98	98	98	98	99	98	97	98	97
	26	0.375	100						98		98	98	98	97	98	98	98	98	97	98	98	98	98	98
	27	0.367	100						99		100	101	100	100	99	101	100	100	101	101	99	100	99	99
	28	0.386	100						100		101	100	100	99	99	100	99	99	100	100	99	99	100	99
	AVERAGE		100						99		99	99	100	99	99	100	99	99	99	100	99	99	99	99
			1176 (1176)	1270* (1270)	1271 (1271)	1380 (1380)	1491 (1491)	1598 (1598)	1727 (1728)	1776 (1777)	1887 (1887)	1982 (1982)	2076 (2077)	2104	2183 (2183)	2277 (2278)	2375 (2375)	2488 (2488)	2596 (2597)	2663 (2664)	2774 (2775)	2833 (2834)	2881 (2881)	2980 (2980)
TEST CELLS ▽2	19		96	96	96	96	96	96	96	95	95	95	95	95	95	95	95	95	94	95	94	95	95	94
	20		96	96	96	96	95	95	95	94	95	94	95	94	95	94	94	94	94	94	93	94	94	93
	21		94	94	94	95	95	95	94	93	93	93	93	93	93	93	93	93	93	93	91	92	93	92
	22		99	99	99	98	99	99	99	98	98	99	99	98	98	99	99	99	99	99	98	98	99	98
	23		98	98	98	98	98	98	98	98	98	98	98	97	98	97	98	98	97	97	97	97	97	96
	AVERAGE		97	97	97	97	97	97	96	96	96	96	96	95	96	96	96	96	95	96	95	95	96	95
CONTROL CELLS ▽3	24		101	101	99	101	100	101	101	102	101	101	101		101	101	101	101	101	101	99	99	101	101
	25		99	99	98	98	98	98	98	99	99	98	98		100	99	98	99	98	98	98	98	99	98
	26		98	98	98	97	98	98	97	98	98	98	97		97	98	98	97	98	98	98	97	97	97
	27		100	100	99	101	99	100	99	101	99	101	101		101	100	101	101	100	102	101	100	101	99
	28		99	100	100	99	99	99	99	99	99	100	99		99	100	99	100	100	100	97	99	99	100
	AVERAGE		99	100	99	99	99	99	99	100	99	100	99		100	100	99	100	99	100	99	99	99	99
			3089 (3089)	3171 (3172)	3284 (3284)	3392 (3393)	3487 (3489)	3504 (3504)	3585 (3585)	3697 (3695)	3808 (3808)	3872 (3872)	3967 (3967)	4093 (4093)	4188 (4188)	4284 (4284)	4361 (4361)	4486 (4486)	4514 (4514)	4581 (4582)	4708 (4708)	4803 (4803)	4840 (4841)	
TEST CELLS ▽2	19		94	94	93	93	93	91	92	92	92	92	92	91	91	92	92	91	92	92	91	91	91	
	20		94	93	93	93	92	91	92	92	92	92	91	91	91	91	91	90	92	91	91	90	91	
	21		93	92	91	91	91	91	91	91	91	90	91	90	90	91	91	90	92	91	91	90	90	
	22		99	99	100	99	99	96	97	98	97	98	98	98	97	98	98	98	98	98	98	98	98	
	23		97	98	98	98	98	95	96	96	95	97	96	96	95	96	96	96	97	96	97	97	97	
	AVERAGE		95	95	95	95	95	93	94	94	93	94	94	93	93	94	94	93	94	94	94	93	93	
CONTROL CELLS ▽3	24		101	101	102	102	101	101	100	101	100	102	99	100	101	101	101	101	101	102	101	101	101	
	25		99	98	99	99	98	99	98	99	98	99	100	98	98	98	99	99	98	99	98	99	98	
	26		98	97	98	98	97	97	98	98	96	99	97	99	98	99	98	97	98	97	97	96	97	
	27		101	101	100	101	100	100	101	101	101	102	100	101	101	101	100	102	100	101	101	100	99	
	28		99	98	100	100	100	99	99	100	100	99	99	100	100	99	99	100	99	98	98	99	100	
	AVERAGE		100	99	100	100	99	99	99	100	99	100	99	100	100	100	99	100	99	99	99	99	99	

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C

▽4 ABSOLUTE VALUES IN VOLTS

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO

Table 17: (Continued)

	CELL NUMBER	CYCLE ▽1 4842	4843	4854	4855	4887 4888)	4984 (4985)	5081 (5081)	5125 (5125)	5223 (5223)	5286 (5286)	5414 (5415)	5497 (5497)	5594 (5594)	5709 (5709)	5821 (5822)	5882 (5882)	5943 (5943)	6056 (6057)	6166 (6167)	6288 (6288)	6390	6499 (6499)
TEST CELLS ▽2	19	92	92	91	93	94	94	94	93	92	92	90	91	90	89	88	88	90	90	90	90	90	90
	20	94	95	94	96	98	98	97	96	96	96	94	94	93	92	91	92	92	93	93	93	91	91
	21	92	92	92	93	94	93	93	91	91	90	87	88	87	86	85	85	89	88	87	87	85	86
	22	99	99	97	99	100	100	100	100	100	100	98	99	100	99	99	100	98	98	98	99	98	98
	23	101	101	100	101	102	101	101	100	100	100	99	99	99	98	97	98	97	98	98	98	96	97
	AVERAGE	96	96	95	96	98	97	97	96	96	96	94	94	94	101	92	93	93	93	93	93	92	93
CONTROL CELLS ▽3	24					101	100	101	101	101	102	100	101	102	97	100	101	101	101	101	101		100
	25					98	99	99	99	97	98	98	98	98	97	98	97	98	98	98	98		98
	26					96	96	97	98	96	98	97	97	96	100	97	97	95	97	96	98		97
	27					104	99	100	100	100	100	100	101	99	99	100	100	101	100	99	100		101
	28					92	99	100	99	98	100	99	99	97	99	98	100	99	98	99	100		99
	AVERAGE					98	99	99	99	98	100	99	99	98	99	99	99	99	99	99	99		99
		6582 (6583)	6608 (6609)	6707 (6707)	6822 (6822)	6912 (6912)	6976 (6977)	7058 (7058)	7249 (7249)	7312 (7312)	7405 (7406)	7510 (7510)	7613 (7614)	7727 (7727)	7923 (7924)								
TEST CELL ▽2	19	88	90	90	89	88	88	89	87	87	86	87	90	90	87								
	20	90	93	93	91	91	90	91	89	89	88	88	92	91	97								
	21	84	89	88	87	86	86	86	85	84	83	84	87	87	84								
	22	97	98	96	97	97	97	98	97	97	97	98	98	98	95								
	23	96	98	98	96	97	96	96	96	96	95	96	97	94	96								
	AVERAGE	91	94	93	92	92	91	92	91	91	90	91	93	92	92								
CONTROL CELLS ▽3	24	101	101	101	99	107	101	102	100	99	100	100	101	100	100								
	25	98	98	99	98	98	99	99	96	98	98	98	98	99	97								
	26	96	97	97	97	97	95	97	96	97	97	97	96	98	96								
	27	99	100	100	101	100	100	101	100	100	100	99	99	101	100								
	28	99	98	100	100	99	99	100	98	99	99	100	98	99	100								
	AVERAGE	99	99	99	99	99	99	100	98	99	99	99	98	99	99								

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE.

Table 18: RELATIVE LOAD CURRENT VERSUS CYCLES FOR GROUP C TEST CELLS AND CONTROL CELLS

	CELL NUMBER	▽4	CYCLE ▽1																					
			1 (1)	13	18	33	77	81	91 (92)	105	136 (136)	183 (183)	216 (217)	247 (247)	295 (295)	404 (404)	515 (515)	579 (579)	674 (674)	774 (774)	788 (788)	866 (866)	975 (975)	1081 (1081)
TEST CELLS ▽2	19	621	100	100	100	100	99	99	98	98	99	99	99	98	98	98	98	97	97	97	98	97	98	97
	20	559	100	100	104	100	99	100	97	98	98	98	98	97	98	98	97	97	97	97	97	96	97	96
	21	607	100	99	99	98	98	98	95	96	97	97	97	97	97	97	96	96	96	96	95	95	95	94
	22	656	100	100	100	100	100	100	98	99	100	100	100	100	99	100	99	100	100	100	100	100	100	99
	23	711	100	100	99	100	100	100	97	98	99	99	99	98	98	99	98	99	98	99	98	98	99	98
	AVERAGE		100	100	100	100	99	99	97	98	99	99	99	98	98	98	98	98	98	98	98	97	98	97
CONTROL CELLS ▽3	24	716	100						101		101	101	101	101	101	101	101	101	101	100	100	101	100	101
	25	640	100						96		97	95	99	98	98	98	98	98	98	99	98	97	98	97
	26	654	100						99		98	98	98	97	98	98	98	98	97	98	98	97	98	97
	27	679	100						99		100	101	100	100	99	101	100	100	101	100	97	100	99	98
	28	819	100						99		100	99	99	99	99	100	99	99	100	100	99	99	100	99
	AVERAGE		100						99		99	99	99	99	99	100	99	99	99	99	98	99	99	98
			1176 (1176)	1270* (1270)	1271 (1271)	1380 (1380)	1491 (1491)	1598 (1598)	1727 (1728)	1776 (1777)	1887 (1887)	1982 (1982)	2076 (2077)	2104	2183 (2183)	2277 (2278)	2375 (2375)	2488 (2488)	2596 (2597)	2663 (2664)	2774 (2775)	2833 (2834)	2881 (2881)	2980 (2980)
TEST CELLS ▽2	19		96	96	96	96	96	96	95	95	95	95	95	95	95	95	94	94	94	95	94	94	94	94
	20		95	95	95	96	95	95	95	94	94	94	94	94	95	94	94	94	93	94	93	93	94	92
	21		93	93	93	94	94	94	93	92	92	92	92	92	92	92	92	92	92	92	90	91	92	91
	22		99	100	100	99	99	99	99	99	99	99	99	99	99	99	99	100	100	100	98	99	99	98
	23		97	98	98	97	97	97	97	97	98	97	97	97	97	97	97	97	96	97	96	96	96	95
	AVERAGE		96	96	96	96	96	96	96	95	96	95	95	95	96	95	96	95	95	96	94	95	95	94
CONTROL CELLS ▽3	24		101	101	99	101	100	101	101	102	101	101	101		101	101	101	101	101	101	100	99	101	101
	25		99	99	97	97	98	98	98	99	99	98	98		100	98	98	99	98	98	98	98	99	98
	26		98	97	98	97	98	98	97	98	98	98	96		97	97	98	97	98	98	98	97	101	97
	27		100	100	99	100	99	100	99	101	99	101	101		100	100	101	101	100	102	100	100	100	99
	28		99	100	100	99	99	99	99	99	99	100	99		99	100	99	100	100	100	97	99	99	100
	AVERAGE		99	99	99	99	99	99	99	100	99	100	99		99	99	99	100	99	98	99	99	100	99
			3089 (3089)	3171 (3172)	3284 (3284)	3392 (3393)	3487 (3489)	3504 (3504)	3585 (3585)	3697 (3695)	3808 (3808)	3872 (3872)	3967 (3967)	4093 (4093)	4188 (4188)	4284 (4284)	4361 (4361)	4486 (4486)	4514 (4514)	4581 (4582)	4708 (4708)	4803 (4803)	4840 (4840)	
TEST CELLS ▽2	19		94	94	93	93	92	91	92	91	92	91	91	91	91	92	91		92	92	91	91	91	
	20		93	93	93	92	92	90	91	91	91	91	91	91	90	90	90	90	91	91	90	90	90	
	21		92	91	91	90	90	90	90	90	90	89	90	89	89	90	90	89	91	90	90	89	89	
	22		100	99	100	100	99	96	97	98	99	98	98	98	98	99	98	98	98	98	98	98	98	
	23		96	98	98	97	97	94	95	95	94	96	95	95	94	95	96	95	96	95	96	96	96	
	AVERAGE		95	95	95	94	94	92	93	93	93	93	93	93	92	93	93	93	94	93	93	93	93	
CONTROL CELLS ▽3	24		101	101	102	102	101	101	100	101	100	102	99	100	101	101	101	101	101	102	101	101	101	
	25		99	98	99	99	98	99	98	99	98	99	99	98	98	98	99	99	98	99	98	99	98	
	26		98	97	98	98	97	97	98	98	97	98	97	98	98	99	98	97	98	96	97	96	97	
	27		101	101	100	101	100	99	100	101	102	102	99	100	100	100	100	102	99	100	101	100	99	
	28		99	98	100	100	100	99	99	100	100	99	99	100	100	99	99	100	99	98	98	99	100	
	AVERAGE		100	99	100	100	99	99	99	100	99	100	99	99	99	99	99	100	99	99	99	99	99	

▽1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS.

▽2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C

▽3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C

▽4 ABSOLUTE VALUES IN MILLIAMPERES

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO

*DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE

Table 18: (Continued)

	CELL NUMBER	4842	4843	4854	4855	4887 (4888)	4984 (4985)	5081 (5081)	5125 (5125)	5223 (5223)	5286 (5286)	5414 (5415)	5497 (5497)	5594 (5594)	5709 (5709)	5821 (5822)	5882 (5882)	5943 (5943)	6056 (6057)	6166 (6167)	6288 (6288)	6390	6499 (6499)
TEST CELLS 2	19	91	91	90	93	94	94	94	93	92	92	90	91	90	90	89	89	91	90	90	90	90	90
	20	93	94	93	96	98	98	97	97	96	96	94	94	94	92	91	92	92	93	93	93	91	91
	21	91	91	90	94	94	94	94	91	91	90	88	88	87	87	85	86	90	89	87	87	85	86
	22	99	99	97	99	100	100	100	100	100	100	98	99	100	99	99	100	98	98	98	99	98	98
	23	100	100	99	101	102	101	101	101	100	100	99	99	99	98	98	98	98	98	98	98	96	97
	AVERAGE	95	95	95	97	98	97	97	96	96	96	94	94	94	93	92	93	94	94	93	93	92	92
CONTROL CELLS 3	24					101	101	101	101	101	102	100	101	102	101	100	101	101	101	101	101		100
	25					98	99	99	99	97	98	93	98	98	97	98	97	98	98	98	98		98
	26					96	96	97	97	96	98	97	97	96	96	97	97	95	97	96	98		97
	27					104	99	99	100	100	99	100	101	99	99	100	100	101	100	99	100		100
	28					92	99	100	99	98	100	99	99	97	99	98	100	99	98	99	100		99
	AVERAGE					98	99	99	99	98	99	99	99	98	98	99	99	99	99	99	99		99

	CELL NUMBER	6582 (6583)	6608 (6609)	6701 (6701)	6822 (6822)	6912 (6912)	6976 (6977)	7058 (7058)	7249 (7249)	7312 (7312)	7405 (7406)	7510 (7510)	7613 (7614)	7727 (7727)	7923 (7924)
TEST CELLS 2	19	88	90	90	89	88	88	89	87	87	86	87	90	90	87
	20	90	93	93	92	91	90	91	89	89	88	88	92	92	97
	21	84	89	88	87	86	86	86	85	85	83	85	88	88	84
	22	97	98	96	97	97	97	98	97	97	97	98	98	98	95
	23	96	98	98	97	97	97	97	96	96	96	96	98	94	96
	AVERAGE	91	94	93	92	92	92	92	91	91	90	91	93	92	92
CONTROL CELLS 3	24	101	101	101	100	102	101	102	100	100	100	100	101	100	100
	25	98	98	99	98	98	99	99	96	98	98	98	98	99	97
	26	96	97	97	96	97	95	97	96	97	97	97	95	98	96
	27	99	100	100	101	100	100	100	100	99	100	99	99	101	100
	28	99	98	100	100	99	99	100	98	99	99	100	98	99	99
	AVERAGE	99	99	99	99	99	99	100	98	99	99	99	98	99	98

1 CYCLE DURING WHICH CONTROL CELL DATA WAS OBTAINED IS GIVEN IN PARENTHESIS.

2 CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 60°C.

3 CELLS IN AIR; DATA CORRECTED TO A CELL TEMPERATURE OF 25°C.

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

* DATA OBTAINED JUST PRIOR TO A X25L LAMP CHANGE.

Table 19: RELATIVE LOAD POWER VERSUS CYCLES AND TIME FOR GROUP D TEST CELLS

	CELL NUMBER	▽1	CYCLE ▽2								HOURS ▽2												
			1	68	84	120	134	182	198	227	1.1	30	30.4	96.5	97.5	144.6	145.4	191.9	193.3	317.4	318.2	455.3	456.1
TEST CELL	29	196	100	100	100	100	99	99	99	98	97	97	97	93	96	96	95	94	92	95	94	94	94
	30	206	100	101	100	101	100	100	100	99	98	94	98	94	96	97	95	94	93	95	95	94	94
	31	201	100	102	100	103	101	100	100	99	99	97	99	93	97	97	96	94	94	95	97	95	95
	32	197	100	96	93	99	96	96	96	94	91	90	91	86	90	91	89	87	87	89	88	87	87
	33	199	100	98	94	111	97	97	96	95	94	90	92	86	90	91	89	87	86	87	87	88	89
	34	197	100	97	95	98	96	97	96	96	93	91	92	88	89	90	90	88	87	88	89	89	88
	STRING	1,198	100	100	97	103	98	98	98	97	96	94	95	90	93	94	93	90	90	92	92	92	91
	35	212	100	97	88	102	101	96	95	95	94	89	93	85	87	90	87	85	84	90	87	87	87
	36	231	100	100	100	101	102	101	101	100	102	100	101	97	—	99	99	96	96	97	95	96	96
	37	227	100	102	101	100	99	97	97	96	97	96	96	94	97	98	96	95	95	94	93	94	94
			509.6	510.6	629.2	630.9	696.4	697.5	819	820.6	936.3	937.7	1012.6	1014.2	1103.5	1104.7	1180.7	1182.2	1295.3	1296.8	1371.1	1439	1532
TEST CELL	29		94	95	94	95	94	95	93	94	93	93	92	90	92	91	90	92	92	91	92	85	88
	30		94	95	94	95	94	95	94	94	94	94	93	91	93	92	97	93	92	92	92	87	89
	31		94	96	95	96	95	96	94	95	93	94	93	92	93	93	92	94	92	93	93	89	91
	32		88	88	88	88	88	89	87	87	87	86	86	85	86	84	85	88	86	84	86	82	85
	33		89	90	88	88	89	89	85	89	88	88	87	85	88	86	84	88	86	86	87	82	85
	34		88	90	90	89	89	90	89	88	87	87	87	85	88	85	83	87	86	86	86	79	82
	STRING		91	92	92	92	92	92	91	91	90	91	90	89	90	89	88	91	89	89	90	84	87
	35		87	89	86	89	88	89	85	86	86	85	85	81	88	85	87	86	88	87	87	83	85
	36		96	96	95	96	96	95	94	94	94	93	93	90	93	91	91	93	91	91	91	90	91
	37		97	97	97	96	97	97	96	94	95	94	94	92	96	92	96	96	93	93	94	94	95
			1633.8	1705.8	1802.9	1943.1	2036.9	2114.0	2201.2	2306.2	2377.3	2473.3	2544.7	2613.1	2712.8	2806.0	2954.1	3015.1	3113.8	3168.7	3328 2		
TEST CELL	29		87	86	89	87	87	85	83	83	82	79	83	86	85	84	83	85	85	80	85		
	30		89	88	88	86	88	87	83	84	83	81	84	87	86	85	84	85	86	80	86		
	31		91	90	87	88	91	90	86	86	86	84	87	89	88	88	87	88	89	83	89		
	32		83	82	84	83	84	81	79	79	79	76	80	81	81	79	79	80	81	75	80		
	33		83	80	84	80	82	80	77	78	78	75	79	80	80	80	80	81	80	73	81		
	34		82	80	80	81	81	79	76	76	76	70	78	79	79	78	77	81	80	75	80		
	STRING		86	84	86	82	86	84	81	81	81	78	82	84	83	83	82	83	84	78	84		
	35		83	83	83	78	83	84	80	79	81	75	82	81	81	81	80	81	80	78	81		
	36		90	88	86	86	85	88	85	85	85	80	86	83	85	83	83	85	83	81	83		
	37		95	95	89	92	90	95	92	92	93	89	94	90	92	90	90	89	89	86	89		

▽1 ABSOLUTE VALUES IN MILLIWATTS

▽2 ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO

CELLS IN VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 55°C

Table 19: (Continued)

TEST CELL	CELL NUMBER	HOURS 3452.6	3615.2	3690.1	3808.0	3974.4	3993.6	4156.7	4309.4	4475.6	4641.5	4809.7	4960.8	5098.5	5194.8	5315	5601	5698	5836	5993	6155	6301	6320
	29	88	86	87	86	84	86	86	85	88	86	86	85	87	85	84	84	84	83	83	81	81	79
	30	87	86	86	86	84	84	84	84	86	84	84	84	86	83	82	83	83	82	82	80	80	78
	31	90	88	89	89	86	89	88	87	89	87	87	86	88	85	85	85	85	85	85	83	83	81
	32	81	78	79	78	76	78	76	75	77	76	75	74	76	73	72	71	71	71	72	70	70	67
	33	82	80	80	80	78	79	78	78	80	79	79	78	80	78	78	78	78	78	77	74	75	73
	34	82	79	79	79	77	77	79	78	81	80	79	79	81	79	77	78	77	78	77	75	75	73
	STRING	85	83	84	83	81	82	82	82	84	82	81	81	83	81	80	80	80	80	79	78	77	75
	35	82	81	81	81	80	81	81	81	82	81	81	81	81	80	80	78	79	79	78	78	78	77
	36	84	82	83	83	81	81	81	80	83	81	80	81	82	81	79	79	78	78	78	77	77	76
	37	87	89	90	91	90	90	90	88	89	89	88	88	86	87	85	86	85	84	85	84	83	82

Table 20: RELATIVE LOAD VOLTAGE VERSUS CYCLES AND TIME FOR GROUP D TEST CELLS

	CELL NUMBER	▽1	RELATIVE VOLTAGE CYCLES ▽2								HOURS ▽2												
			1	68	84	120	134	182	198	227	1.1	30	30.4	96.5	97.5	144.6	145.4	191.9	193.3	317.4	318.2	455.3	456.1
TEST CELL	29	0.323	100	100	101	99	100	100	100	100	99	100	100	98	99	99	99	99	97	99	99	99	98
	30	0.339	100	101	102	100	101	101	101	100	101	101	101	99	100	100	99	100	99	99	99	99	99
	31	0.332	100	109	101	101	102	101	101	100	101	100	101	99	101	100	100	100	99	99	101	99	100
	32	0.326	100	96	94	97	97	96	96	95	93	93	94	91	93	93	92	91	92	92	91	91	91
	33	0.328	100	98	95	110	98	98	97	97	96	93	95	91	93	94	93	91	91	91	91	92	93
	34	0.324	100	98	97	97	97	98	97	97	95	93	94	93	92	93	93	93	91	92	92	93	92
	STRING	1.976	100	100	99	101	99	99	99	99	98	97	98	95	96	97	96	95	95	96	96	96	96
	35	0.321	100	98	94	101	101	98	98	98	97	94	96	93	93	95	94	92	92	95	94	94	94
	36	0.311	100	100	100	101	101	100	100	100	101	100	101	99	--	100	99	98	98	98	97	98	98
	37	0.310	100	101	100	100	100	99	99	98	99	98	98	97	99	99	98	98	98	97	96	97	97
			509.6	510.6	629.2	630.9	696.4	697.5	819	820.6	936.3	937.7	1012.6	1014.2	1103.5	1104.7	1180.7	1182.2	1295.3	1296.8	1371.1	1439	1532
TEST CELL	29		99	99	98	99	99	99	98	98	98	98	98	96	97	97	97	97	98	97	97	94	95
	30		99	99	99	99	99	99	99	99	98	98	98	97	98	97	98	98	98	97	97	96	96
	31		99	100	99	100	101	100	99	99	98	99	98	98	98	99	99	99	98	99	98	98	98
	32		92	92	92	91	92	92	91	91	91	90	91	90	91	89	91	92	90	89	90	90	91
	33		93	93	92	92	92	92	89	93	92	92	92	91	93	92	89	93	91	91	91	91	91
	34		92	93	94	93	94	94	93	92	92	92	91	91	92	91	88	91	91	91	91	87	88
	STRING		96	96	96	96	96	96	95	95	95	95	95	94	95	94	94	95	94	94	95	93	93
	35		94	94	93	94	94	95	92	93	93	92	92	90	94	92	93	93	94	93	93	91	92
	36		98	98	97	98	98	97	97	97	97	96	96	95	96	96	96	96	96	95	96	95	95
	37		99	99	99	98	99	99	98	97	98	97	97	96	98	96	98	98	96	96	97	97	97
			1633.8	1705.8	1802.9	1943.1	2036.9	2114.0	2201.2	2306.2	2377.3	2473.3	2544.7	2613.1	2712.8	2806.0	2954.1	3015.1	3113.8	3168.7	3328.2		
TEST CELL	29		93	93	97	96	94	93	92	93	92	91	92	93	93	92	92	94	93	92	93		
	30		96	95	95	95	96	95	93	94	93	92	94	95	94	94	94	93	94	91	94		
	31		98	98	94	97	98	98	96	96	96	96	96	97	97	97	97	96	97	95	97		
	32		90	90	90	92	90	89	88	88	88	87	88	89	88	87	87	87	88	85	87		
	33		90	87	90	89	89	88	87	87	87	85	87	88	87	87	88	89	88	83	89		
	34		88	87	87	90	88	87	85	84	85	80	87	87	87	86	85	88	88	85	88		
	STRING		93	92	93	91	93	92	90	90	90	89	91	92	91	91	90	91	91	89	91		
	35		91	91	91	89	91	92	90	89	90	87	90	90	90	90	90	90	90	89	90		
	36		95	94	93	93	92	94	92	92	92	90	93	91	92	91	91	92	91	90	91		
	37		97	97	95	96	95	97	96	96	96	94	97	95	96	95	95	95	94	93	94		

▽1 ABSOLUTE VALUES IN VOLTS

▽2 ALL OPEN-CIRCUIT VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 55°C.

Table 20: (Continued)

TEST CELL	CELL NUMBER	HOURS 3452.6	3615.2	3690.1	3808.0	3974.4	3993.6	4156.7	4309.4	4475.6	4641.5	4809.7	4960.8	5098.5	5194.8	5315	5601	5698	5836	5993	6155	6301	6320
	29	95	95	95	94	94	94	95	95	96	95	95	95	96	94	94	94	94	93	93	92	92	92
	30	94	94	94	94	93	92	93	93	94	93	93	93	94	93	92	94	93	92	92	91	91	91
	31	98	97	97	97	96	98	97	96	97	96	96	95	96	95	95	95	95	96	96	94	94	93
	32	87	85	86	86	85	86	85	83	84	83	83	82	83	81	80	80	80	80	81	80	79	78
	33	89	87	88	87	86	87	86	86	87	87	87	87	88	87	87	87	87	87	86	85	85	84
	34	89	87	87	87	85	85	88	87	88	88	88	87	89	88	87	87	87	87	86	85	86	84
	STRING	92	91	91	91	90	90	91	90	91	90	90	90	91	90	89	89	89	89	89	88	88	87
	35	91	90	90	90	89	90	90	90	91	90	90	90	90	89	89	89	89	89	88	88	88	88
	36	91	90	91	91	90	90	90	90	91	90	90	90	90	90	89	89	89	88	88	88	88	87
	37	93	94	95	95	95	95	95	94	94	95	94	94	93	93	92	93	92	92	92	92	91	91

Table 21: RELATIVE LOAD CURRENT VERSUS CYCLES AND TIME FOR GROUP D TEST CELLS

	CELL NUMBER	(1)	CYCLE (2) 1	68	84	120	134	182	198	227	HOURS (2) 1.1	30	30.4	96.5	97.5	144.6	145.4	191.9	193.3	317.4	318.2	455.3	456.1
TEST CELL	29	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	30	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	31	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	32	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	33	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	34	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	STRING	0.607	100	100	99	101	99	99	99	98	98	97	98	95	97	97	96	95	95	96	96	96	96
	35	0.660	100	99	94	101	101	98	98	98	97	94	96	92	93	95	93	92	92	95	93	93	93
	36	0.744	100	100	100	101	101	100	100	100	101	100	101	99	--	100	99	98	98	98	97	98	98
	37	0.731	100	101	101	100	100	99	99	98	99	98	98	97	99	99	98	98	98	97	96	97	97
			509.6	510.6	629.2	630.9	696.4	697.5	819.0	820.6	936.3	937.7	1,012.6	1,014.2	1,103.5	1,104.7	1180.7	1182.2	1295.3	1296.8	1371.1	1439	1532
TEST CELL	29		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	30		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	31		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	32		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	33		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	34		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	STRING		96	96	96	96	96	96	95	96	95	95	95	94	95	94	94	95	94	94	95	91	93
	35		93	94	93	94	94	94	92	92	93	92	92	90	94	92	93	93	94	93	93	91	92
	36		98	98	97	98	98	97	97	97	97	96	96	95	96	96	96	96	96	95	95	95	95
	37		99	99	99	98	99	99	98	97	98	97	97	96	98	96	98	98	96	96	97	97	98
			1633.8	1705.8	1802.9	1943.1	2036.9	2114.0	2201.2	2306.2	2377.3	2473.3	2544.7	2613.1	2712.8	2806.0	2954.1	3015.1	3113.8	3168.7	3328.2		
TEST CELL	29		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	30		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	31		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	32		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	33		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	34		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	STRING		93	92	93	90	93	91	90	90	90	88	90	92	91	91	90	91	92	88	92		
	35		91	91	91	88	91	92	89	89	90	86	90	90	90	90	90	90	89	88	90		
	36		95	94	93	93	92	94	92	92	92	90	93	91	92	91	91	92	91	90	91		
	37		98	97	94	96	95	97	96	96	93	94	97	95	96	95	95	95	95	93	95		

(1) ABSOLUTE VALUES IN MILLIAMPERES

(2) ALL SHORT-CIRCUIT CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE-1 VALUES. LIGHT INTENSITY WAS AMO.

CELLS UNDER VACUUM; DATA CORRECTED TO A CELL TEMPERATURE OF 55°C.

Table 21: (Continued)

TEST CELL	CELL NUMBER	HOURS 3452.6	3615.2	3690.1	3808.0	3974.4	3993.6	4156.7	4309.4	4475.6	4641.5	4809.7	4960.8	5098.5	5194.8	5315	5601	5698	5836	5993	6155	6301	6320
TEST CELL	29	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	30	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	31	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	32	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	33	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	34	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	STRING	92	91	92	91	90	91	91	90	92	90	90	90	92	90	90	89	89	89	89	88	88	86
	35	90	90	90	91	89	90	90	90	90	90	90	90	90	89	89	88	89	89	88	88	88	87
	36	91	91	91	91	90	90	90	90	91	90	90	90	91	90	89	88	89	88	88	88	88	87
	37	93	95	95	95	95	95	95	94	95	95	94	94	93	93	92	93	92	92	92	92	91	91

Table 22: RELATIVE LOAD POWER VERSUS CYCLES AND TIME FOR GROUP D CONTROL CELLS

	CELL NUMBER	▽1	CYCLE																			
							HOURS															
			1	68	87	100	819	1127.5	1152.4	1275.8	1443.4	1584.9	1643.6	2160	2301	2377.3	2522.2	2616.8	2808.2	2972.2	2996.2	3112.5	3186.2	3475.4
CONTROL CELL	38	246	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	105	–	–	–
	39	247	100	99	100	101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	107	–	–	–
	40	240	100	98	100	101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	107	–	–	–
	41	237	100	102	100	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	109	–	–	–
	42	232	100	101	100	101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	108	–	–	–
	43	243	100	100	100	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	102	–	–	–
	STRING	1314	100	100	100	101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	97	–	–	–
	44	266	100	100	100	100	91	92	89	90	91	90	90	92	92	91	91	92	92	92	–	92	92	90
	45	257	100	102	100	101	101	100	99	99	99	99	100	100	98	100	100	100	98	99	–	99	99	101
	46	241	100	101	100	99	104	108	107	108	106	107	106	107	106	106	106	107	109	107	–	107	106	108
			3566.6	3687.9	3855.6	3975.1	4162.4	4312.6	4476.6	4601.6	4645.6	4791.5	4962.5	5097.5	5194	5316	5601	5697	5836	5993	6155	6320		
CONTROL CELL	38		–	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	39		–	–	–	103	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	40		–	–	–	106	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	41		–	–	–	109	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	42		–	–	–	105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	43		–	–	–	97	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	STRING		–	–	–	124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	44		90	89	91	90	92	88	92	91	92	90	90	92	90	91	91	92	92	91	90	92		
	45		100	97	99	99	100	92	97	97	98	100	99	100	98	99	99	98	97	99	99	99		
	46		106	105	108	108	107	98	106	106	106	106	106	106	106	107	106	107	105	104	106	105		
CONTROL CELL																								

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE 1 VALUES

▽1 ABSOLUTE VALUES IN MILLIWATTS

Table 23: RELATIVE LOAD VOLTAGE CYCLES AND TIME FOR GROUP D CONTROL CELLS

	CELL NUMBER	▽1	CYCLE			HOURS																	
			1	68	87	100	819	1127.5	1152.4	1275.8	1443.4	1584.9	1643.6	2160	2301	2377.3	2511.7	2616.8	2808.2	2972.2	2996.2	3112.5	3186.2	3475.4
CONTROL CELL	38	0.378	100	100	100	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	97	—	—	—
	39	0.380	100	98	100	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	99	—	—	—
	40	0.370	100	98	100	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	99	—	—	—
	41	0.365	100	101	100	99	—	—	—	—	—	—	—	—	—	—	—	—	—	—	101	—	—	—
	42	0.357	100	101	100	101	—	—	—	—	—	—	—	—	—	—	—	—	—	—	99	—	—	—
	43	0.374	100	100	100	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	94	—	—	—
	STRING	2.022	100	100	100	110	—	—	—	—	—	—	—	—	—	—	—	—	—	—	98	—	—	—
	44	0.380	100	100	100	100	95	96	95	95	95	95	95	96	96	95	96	96	96	96	—	96	96	95
	45	0.373	100	101	100	101	101	100	100	100	100	100	100	100	99	100	100	100	99	100	—	100	100	101
	46	0.365	100	100	100	100	102	104	103	104	103	103	103	104	103	103	103	104	104	104	—	104	103	104
			3566.6	3687.9	3855.6	3975.1	4162.4	4312.6	4476.6	4601.6	4645.6	4791.5	4962.5	5097.5	5194	5316	5601	5697	5836	5993	6155	6320		
CONTROL CELL	38		—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	39		—	—	—	102	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	40		—	—	—	103	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	41		—	—	—	105	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	42		—	—	—	103	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	43		—	—	—	99	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	STRING		—	—	—	111	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	44		95	95	95	95	96	94	96	96	96	95	95	96	95	96	96	96	96	96	95	96		
	45		100	99	100	100	100	96	99	99	99	100	100	100	99	100	100	99	98	100	100	100		
	46		103	102	104	104	103	99	103	103	103	103	103	103	103	103	103	104	102	102	103	102		
CONTROL CELL																								

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE 1 VALUES

▽1 ABSOLUTE VALUES IN VOLTS

Table 24: RELATIVE LOAD CURRENT VERSUS CYCLES AND TIME FOR GROUP D CONTROL CELLS

	CONTROL CELL NUMBER	▽1	CYCLE				HOURS																	
			1	68	87	100	819	1127.5	1152.4	1275.8	1443.4	1584.9	1643.6	2160	2301	2377.3	2522.2	2616.8	2808.2	2972.2	2996.2	3112.5	3186.2	3475.4
CONTROL CELLS	38	0.650	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	98	–	–	–
	39	0.650	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	98	–	–	–
	40	0.650	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	98	–	–	–
	41	0.650	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	98	–	–	–
	42	0.650	100	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	98	–	–	–
	43	0.650	100	100	100	100	–	–	–	–	–	–	–	–		–	–	–	–	–	98	–	–	–
	STRING	0.650	100	100	100	100	–	–	–	–	–	–	–	–		–	–	–	–	–	98	–	–	–
	44	0.700	100	100	100	100	95	96	94	95	95	95	95	96	96	95	96	96	96	96	–	96	96	95
	45	0.690	100	101	100	100	101	100	100	100	100	99	100	100	99	100	100	100	99	100	–	99	100	100
	46	0.660	100	100	100	100	102	104	103	104	103	103	103	104	103	103	103	104	104	104	–	104	103	104
			3566.6	3687.9	3855.6	3975.1	4162.4	4312.6	4476.6	4601.6	4645.6	4791.5	4962.5	5097.5	5194	5316	5601	5697	5836	5993	6155	6320		
CONTROL CELLS	38		–	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	39		–	–	–	102	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	40		–	–	–	103	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	41		–	–	–	105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	42		–	–	–	103	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	43		–	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	STRING		–	–	–	111	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
	44		95	94	95	95	96	94	96	96	96	95	95	96	95	96	96	96	96	96	95	96		
	45		100	99	99	99	100	96	99	99	99	100	100	100	99	100	100	99	98	99	100	100		
	46		103	102	104	104	103	99	103	103	103	103	103	103	103	103	103	104	102	102	103	102		
CONTROL CELLS																								

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR CYCLE I VALUES

▽1 ABSOLUTE VALUES IN MILLIAMPERES

Table 25: RELATIVE LOAD POWER VERSUS HOURS FOR GROUP E TEST CELLS

	CELL NUMBER	HOURS																					
		2	19	46	71	142	191	238	309	377	477	643	854	1023	1189	1309	1477	1665	1904	2047	2192	2330	2546
TEST CELLS	56	100	100	98	99	99	98	97	97	97	96	95	95	94	93	92	91	91	90	90	90	90	89
	57	100	98	96	97	97	95	95	94	94	93	91	91	89	88	88	87	86	85	83	84	85	84
	58	100	100	98	98	98	97	97	96	96	95	95	94	92	91	91	90	90	89	88	88	88	89
	59	100	100	98	99	99	99	99	99	98	98	98	98	97	97	97	96	95	96	95	95	95	94
	60	100	101	100	100	100	100	99	99	100	99	100	100	99	98	99	98	98	98	97	97	97	98
	61	100	99	97	97	96	94	94	93	93	91	90	89	86	85	85	85	84	83	81	81	83	82
	62	100	96	95	95	96	94	94	94	93	92	92	91	90	90	89	89	88	87	85	86	85	85
	63	100	97	95	95	94	92	91	91	90	88	87	86	83	82	82	81	80	78	76	76	77	76
	64	100	100	98	98	97	95	94	94	93	91	90	88	86	85	85	84	84	82	81	80	80	79
		2641																					
TEST CELLS	56	89																					
	57	83																					
	58	88																					
	59	94																					
	60	97																					
	61	81																					
	62	84																					
	63	75																					
	64	79																					

ALL LOAD POWER ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

Table 26: RELATIVE LOAD VOLTAGE VERSUS HOURS FOR GROUP E TEST CELLS

	CELL NUMBER	HOURS																					
		2	19	46	71	142	191	238	309	377	477	643	854	1023	1189	1309	1477	1665	1904	2047	2192	2330	2546
TEST CELLS	56	100	99	98	99	98	98	98	98	98	97	97	96	96	95	95	94	94	94	94	94	95	94
	57	100	99	98	99	98	97	97	97	97	96	96	95	94	94	94	93	93	92	91	92	92	92
	58	100	99	98	99	99	98	98	98	98	97	97	97	96	95	95	94	95	94	93	93	94	94
	59	100	100	99	99	99	99	99	99	99	98	99	99	98	98	98	97	97	97	97	97	97	96
	60	100	99	99	99	100	99	99	99	100	100	100	100	100	100	100	99	99	99	99	99	99	100
	61	100	99	98	98	98	97	97	97	97	96	95	94	93	93	93	92	92	91	90	90	91	90
	62	100	98	98	98	98	98	97	97	97	96	96	96	95	95	95	94	94	93	92	93	93	92
	63	100	98	97	97	97	96	96	95	95	94	93	93	92	91	91	90	89	89	87	87	88	87
	64	100	100	99	99	98	97	97	97	97	95	95	94	93	92	92	92	92	91	90	89	90	90

	CELL NUMBER	2641
TEST CELLS	56	94
	57	91
	58	94
	59	96
	60	99
	61	90
	62	92
	63	87
	64	89

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

Table 27: RELATIVE LOAD CURRENT VERSUS HOURS FOR GROUP E TEST CELLS

	CELL NUMBER	HOURS																						
		2	19	46	71	142	191	238	309	377	477	643	854	1023	1189	1309	1477	1665	1904	2047	2192	2330	2546
TEST CELLS	56	100	100	100	100	100	100	99	99	99	99	98	98	98	97	97	96	96	96	95	96	95	95
	57	100	99	98	98	98	98	98	97	97	97	96	95	94	94	94	94	93	92	92	92	92	92
	58	100	101	100	100	100	100	99	99	99	98	98	97	96	96	96	96	96	95	94	94	94	94
	59	100	100	100	100	100	100	100	100	100	100	99	99	99	99	99	99	98	98	98	98	97	97
	60	100	101	100	101	101	100	100	100	100	99	99	99	99	99	99	99	99	98	98	98	98	98
	61	100	100	98	98	98	97	97	96	94	96	95	94	93	92	92	92	92	91	91	90	91	91
	62	100	98	97	97	97	97	96	96	96	96	95	95	94	94	94	94	94	93	92	92	92	91
	63	100	98	98	98	97	96	95	95	95	94	93	92	91	91	90	90	89	88	87	87	88	87
	64	100	99	99	98	98	97	97	96	96	95	95	93	93	92	92	92	91	90	89	89	89	89

	CELL NUMBER	2641
TEST CELLS	56	95
	57	91
	58	94
	59	97
	60	98
	61	90
	62	91
	63	86
	64	89

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

Table 28: RELATIVE LOAD POWER VERSUS HOURS FOR GROUP F TEST CELLS

	CELL NUMBER	HOURS																					
		2	26	49	74	145	193	242	311	380	480	645	686	853	1023	1189	1303	1472	1681	1803	1893	2035	2182
TEST CELLS	47	100	97	97	96	97	97	97	96	96	96	95	95	95	94	94	92	91	90	90	93	91	91
	48	100	100	98	98	98	97	98	96	96	96	95	94	95	93	94	92	90	92	90	92	91	91
	49	100	101	100	99	98	99	100	97	97	97	96	97	96	95	94	94	92	92	92	92	92	92
	50	100	99	99	97	97	97	98	96	97	96	95	95	95	95	95	94	93	93	92	95	95	95
	51	100	98	99	96	96	102	98	96	97	97	97	95	95	96	95	95	93	93	93	94	94	93
	52	100	96	95	93	92	92	93	90	90	88	87	89	87	85	83	84	81	82	80	83	81	81
	53	100	98	96	94	94	93	92	90	90	89	87	87	87	85	84	83	81	82	80	85	83	83
	54	100	100	99	97	96	95	95	93	92	90	89	89	87	86	84	83	80	81	79	83	82	80
	55	100	99	98	96	94	93	93	92	90	88	86	88	86	84	82	83	79	81	79	82	82	80

		2325	2540	2635
TEST CELLS	47	91	89	90
	48	91	90	90
	49	91	89	90
	50	95	94	94
	51	94	92	92
	52	80	76	78
	53	83	81	81
	54	80	78	78
	55	80	78	78

ALL LOAD POWER VALUES ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

Table 29: RELATIVE LOAD VOLTAGE VERSUS HOURS FOR GROUP F TEST CELLS

	CELL NUMBER	HOURS																					
		2	26	49	74	145	193	242	311	380	480	645	686	853	1023	1189	1303	1472	1681	1803	1892	2035	2181
TEST CELLS	47	100	99	99	98	99	99	99	98	98	99	98	98	98	97	98	97	96	96	95	97	96	96
	48	100	100	100	99	100	99	99	98	99	99	98	98	98	97	97	97	96	97	96	97	97	96
	49	100	101	100	99	99	100	100	99	99	100	98	99	98	97	97	97	97	97	96	97	97	96
	50	100	100	100	98	98	99	99	98	98	99	98	98	97	98	98	97	97	97	96	98	97	97
	51	100	100	100	98	98	99	100	98	99	100	98	98	98	98	98	98	97	97	97	97	97	97
	52	100	99	98	97	96	97	96	95	95	96	94	95	94	93	91	92	90	91	90	92	90	90
	53	100	100	98	98	98	97	96	95	95	96	94	94	93	93	93	92	91	91	90	93	92	92
	54	100	100	100	98	98	98	98	96	95	96	95	95	93	93	92	92	90	91	89	91	91	89
	55	100	100	99	98	97	96	97	96	95	95	93	94	92	91	91	91	89	90	89	90	91	90
		2325	2540	2635																			
TEST CELLS	47	96	95	96																			
	48	96	95	95																			
	49	96	94	95																			
	50	98	97	97																			
	51	97	96	96																			
	52	90	89	89																			
	53	92	91	91																			
	54	89	89	88																			
	55	89	88	88																			

ALL LOAD VOLTAGE VALUES ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

Table 30: RELATIVE LOAD CURRENT VERSUS HOURS FOR GROUP F TEST CELLS

	CELL NUMBER	HOURS 2	26	49	74	145	193	242	311	380	480	645	686	853	1023	1189	1303	1472	1681	1803	1893	2035	2181
TEST CELLS	47	100	98	98	97	98	98	98	97	97	97	97	97	97	96	97	96	95	95	95	96	95	95
	48	100	99	99	98	98	98	98	98	98	96	97	97	97	96	96	96	95	95	95	95	95	95
	49	100	100	100	99	100	100	100	98	99	97	98	98	98	98	97	97	96	96	96	96	96	96
	50	100	99	99	99	99	99	99	99	99	97	98	97	98	98	98	97	96	96	96	97	98	98
	51	100	99	99	98	98	103	99	98	98	97	98	97	97	98	97	97	96	96	96	96	96	96
	52	100	98	97	96	96	96	96	95	95	93	93	94	94	92	91	91	90	90	89	91	91	90
	53	100	98	97	96	96	96	95	95	94	93	93	92	92	92	91	91	89	90	89	91	90	90
	54	100	99	99	99	98	97	97	96	96	94	94	94	94	93	92	91	89	89	89	91	90	90
	55	100	99	99	98	97	96	96	95	94	93	93	94	93	91	90	95	89	89	88	90	90	90
		2325	2540	2635																			
TEST CELLS	47	95	95	95																			
	48	95	94	94																			
	49	96	94	95																			
	50	98	97	97																			
	51	96	96	96																			
	52	90	85	88																			
	53	91	89	89																			
	54	90	88	88																			
	55	89	88	88																			

ALL LOAD CURRENT VALUES ARE GIVEN IN PERCENT OF THEIR HOUR 2 VALUES

8.0 APPENDIX

Table A-1: LIST OF EQUATIONS

$$P_M = P_{MU} + K_{MP} (T_R - T)$$

$$V_{OC} = V_{OCU} + K_{OVC} (T_R - T)$$

$$FF = \frac{P_M}{(V_{OC})\ (I_{SC})} \times 100$$

$$P_L = P_{LU} + K_{LP} (T_R - T)$$

$$V_L = V_{LU} + K_{LV} (T_R - T)$$

$$I_L = P_L/V_L$$

$$P_{LU} = V_{LU}^2/R_L$$

$$P_M' = P_M/P_M\ (1)$$

$$V_{OC}' = V_{OC}/V_{OC}\ (1)$$

$$I_{SC}' = I_{SC}/I_{SC}\ (1)$$

$$FF' = FF/FF\ (1)$$

$$P_L' = P_L/P_L\ (1)$$

$$V_L' = V_L/V_L\ (1)$$

$$I_L' = I_L/I_L\ (1)$$

See Table A2 for definitions of the above symbols.

Table A-2: LIST OF SYMBOLS

FF	=	fill factor
FF(1)	=	fill factor at Cycle 1 (percent)
FF'	=	relative fill factor (percent)
I_{SC}	=	short-circuit current (milliamperes)
$I_{SC}(1)$	=	short-circuit current at Cycle 1 (milliamperes)
I_{SC}'	=	relative short-circuit current (percent)
K_{LV}	=	temperature coefficient of load voltage (volts/$^{\circ}$C)
K_{LP}	=	temperature coefficient of load power (milliwatts/$^{\circ}$C)
K_{MP}	=	temperature coefficient of maximum power (milliwatts/$^{\circ}$C)
K_{OCV}	=	temperature coefficient of open-circuit voltage (volts/$^{\circ}$C)
P_L	=	corrected load power (milliwatts)
$P_L(1)$	=	corrected load power at Cycle 1 (milliwatts)
P_L'	=	relative maximum power (percent)
P_{LU}	=	uncorrected load power (milliwatts)
P_M	=	corrected maximum power (milliwatts)
$P_M(1)$	=	corrected maximum power at Cycle 1 (milliwatts)
P_M'	=	relative maximum power (percent)
P_{MU}	=	uncorrected maximum power (milliwatts)
R_L	=	total load resistance across solar cell electrodes (ohms)
T	=	actual cell temperature ($^{\circ}$C)
T_R	=	reference cell temperature ($^{\circ}$C)
V_L	=	corrected load voltage (volts)
$V_L(1)$	=	load voltage at Cycle 1 (volts)
V_L'	=	relative load voltage (percent)
V_{LU}	=	uncorrected load voltage (volts)
V_{OC}	=	open-circuit voltage (volts)
$V_{OC}(1)$	=	open-circuit voltage at Cycle 1 (volts)
V_{OC}'	=	relative open-circuit voltage (percent)
V_{OCU}	=	uncorrected open-circuit voltage (volts)

Table A-3: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
A	1	N153AK7	25	66.6	0.360	725	261	0.462	850	3.39
			35	65.4	0.345	720	248	0.450	842	3.23
			45	63.9	0.326	710	232	0.432	842	3.02
			60	61.9	0.308	690	212	0.411	834	2.78
	2	N319BK2	25	66.7	0.355	714	253	0.453	838	3.29
			35	66.4	0.348	710	247	0.447	833	3.21
			45	65.2	0.325	718	233	0.430	832	3.03
			60	63.3	0.305	700	213	0.408	824	2.77
	3	N310CK9	25	66.8	0.372	657	244	0.469	780	3.17
			35	65.7	0.355	660	234	0.455	782	3.05
			45	65.4	0.340	649	221	0.437	775	2.87
			60	64.0	0.320	640	205	0.415	772	2.66
	4	N315BK4	25	65.6	0.363	614	223	0.453	749	2.90
			35	65.8	0.348	623	217	0.441	749	2.82
			45	65.1	0.335	626	210	0.425	759	2.73
			60	63.9	0.306	634	194	0.402	756	2.52
	5	N311BK5	25	64.8	0.343	650	223	0.440	782	2.90
			35	66.6	0.342	658	225	0.428	790	2.93
			45	64.2	0.325	650	211	0.416	792	2.74
			60	63.5	0.308	644	198	0.400	789	2.58

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-4: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
	10	N152BK7	24	67.4	0.356	752	268	0.461	863	3.48
			35	66.4	0.341	756	258	0.445	873	3.35
			45	64.1	0.327	728	238	0.428	868	3.09
			60	62.9	0.300	726	218	0.403	860	2.83
	11	N320BK4	24	66.3	0.362	705	255	0.455	846	3.31
			35	65.5	0.350	700	245	0.445	840	3.18
			46	64.6	0.332	702	233	0.426	846	3.03
			60	63.1	0.306	698	214	0.406	837	2.78
	12	N310CK5	25	69.2	0.366	678	248	0.456	787	3.22
			35	69.3	0.354	698	247	0.450	792	3.21
			46	66.7	0.334	678	224	0.425	790	2.91
			60	66.2	0.323	664	214	0.411	787	2.78
	13	N315CK6	25	66.9	0.372	605	225	0.455	740	2.92
			35	66.5	0.352	630	222	0.444	752	2.88
			46	65.9	0.339	622	211	0.427	750	2.74
			60	64.2	0.314	622	195	0.406	748	2.54
	14	N311CK8	25	68.3	0.366	688	252	0.465	794	3.28
			35	67.6	0.361	672	242	0.452	794	3.14
			46	66.2	0.333	690	230	0.434	800	2.99
			60	65.0	0.324	652	211	0.412	790	2.74

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-5: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
B	6	N319BKA	25	68.2	0.351	737	259	0.449	846	3.36
			35	67.2	0.350	727	254	0.445	849	3.31
			45	66.6	0.332	733	243	0.429	850	3.16
			60	65.4	0.306	730	223	0.407	840	2.90
	7	N310BK7	25	67.4	0.353	687	242	0.452	795	3.16
			35	66.8	0.342	687	235	0.441	799	3.05
			45	66.4	0.327	690	226	0.426	800	2.93
			60	64.1	0.307	674	207	0.406	796	2.69
	8	N315BK1	25	69.3	0.362	642	232	0.452	742	3.02
			35	68.8	0.353	643	227	0.445	742	2.95
			45	68.1	0.339	652	221	0.432	751	2.97
			60	67.5	0.318	640	204	0.407	742	2.64
	9	N311AK1	25	67.3	0.352	690	243	0.455	794	3.16
			35	66.3	0.342	682	234	0.442	798	3.03
			45	65.0	0.327	683	223	0.429	800	2.90
			60	64.8	0.312	671	209	0.406	795	2.72

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-6: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
B	15	N321BK3	25 35 45 60	68.8 68.0 66.3 64.4	0.372 0.360 0.330 0.320	730 728 728 701	272 262 240 224	0.475 0.458 0.434 0.418	832 840 834 830	3.53 3.40 3.12 2.91
	16	N318BK6	25 35 46 60	66.0 66.6 66.2 64.8	0.338 0.334 0.325 0.305	663 658 648 640	224 220 211 195	0.441 0.428 0.413 0.394	770 770 771 764	2.91 2.86 2.74 2.54
	17	N311CK6	25 35 46 60	69.4 68.9 68.5 66.2	0.370 0.367 0.354 0.327	650 652 638 630	241 239 226 206	0.461 0.462 0.439 0.416	755 757 752 748	3.14 3.10 2.94 2.68
	18	N317BK5	25 35 46 60	65.6 66.4 65.5 64.8	0.340 0.330 0.314 0.302	671 669 675 650	228 221 212 196	0.441 0.426 0.412 0.389	789 782 788 779	2.96 2.87 2.76 2.55

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-7: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
C	19	91154	25	66.8	0.344	697	240	0.444	809	3.13
			35	65.6	0.333	681	227	0.429	807	2.96
			46	64.6	0.312	689	215	0.416	800	2.80
			60	61.9	0.293	662	194	0.393	798	2.53
	20	91746	25	71.0	0.389	628	244	0.484	710	3.18
			35	69.6	0.368	632	233	0.466	718	3.04
			45	68.4	0.353	618	218	0.450	708	2.84
			60	65.7	0.336	592	199	0.428	708	2.60
	21	88861	25	70.6	0.377	652	246	0.473	737	3.21
			35	69.5	0.350	670	235	0.456	741	3.07
			45	67.6	0.345	641	221	0.442	740	2.88
			60	64.9	0.319	629	201	0.419	739	2.62
	22	81-8-6-5	25	72.7	0.365	687	251	0.457	756	3.27
			35	71.2	0.354	666	236	0.446	743	3.08
			45	69.2	0.334	680	227	0.428	766	2.96
			60	67.4	0.314	679	213	0.406	778	2.78
	23	82-1-4-5	25	69.1	0.368	748	275	0.460	865	3.59
			35	68.2	0.348	759	264	0.446	868	3.44
			45	67.3	0.336	755	254	0.434	870	3.31
			60	65.3	0.310	740	229	0.410	855	2.99

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-8: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Effi-ciency (%)
	Boeing No.	Mfg No.								
C	24	93154	25	68.8	0.357	718	256	0.451	825	3.34
			35	68.3	0.342	710	243	0.430	828	3.17
			45	67.2	0.326	711	232	0.418	826	3.03
			60	63.6	0.300	700	210	0.393	815	2.74
	25	89641	25	70.5	0.379	632	240	0.477	714	3.13
			35	69.4	0.372	622	231	0.465	716	3.01
			45	68.0	0.348	636	221	0.452	719	2.88
			60	66.0	0.328	614	201	0.428	712	2.62
	26	88867	25	68.8	0.373	650	242	0.472	745	3.16
			35	67.9	0.353	649	229	0.453	745	2.99
			45	65.7	0.337	627	211	0.434	740	2.75
			60	64.1	0.319	617	197	0.417	737	2.57
	27	81-7-6-3	25	69.9	0.364	673	245	0.455	770	3.20
			35	70.3	0.348	686	239	0.442	769	3.12
			45	69.2	0.337	677	228	0.428	770	2.97
			60	67.3	0.320	664	212	0.409	770	2.77
	28	81-1-5-9	25	67.7	0.360	758	273	0.459	878	3.56
			35	67.0	0.339	762	258	0.442	871	3.37
			45	65.8	0.327	755	247	0.428	877	3.22
			60	64.9	0.312	731	228	0.407	863	2.97

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-9: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification: Boeing No.	Cell Identification: Mfg No.	Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
D TEST CELLS	String	117-6-5-9C 117-7-4-8D 119-7-4-6D 119-8-6-8E 119-8-6-7E 130-7-6-2B	25	3.241	2.416	745	1,801	2.860	-	3.90
			35	3.241	2.307	712	1,642	2.760	-	3.56
			45	3.241	2.183	673	1,470	2.660	-	3.18
			60	3.241	1.987	613	1,218	2.530	730	2.64
	35	130-4-4-4A	25	0.485	0.353	728	257	0.481	-	3.34
			35	0.485	0.345	711	245	0.465	-	3.19
			45	0.485	0.337	695	234	0.450	-	3.04
			60	0.485	0.321	662	213	0.425	760	2.77
	36	119-7-4-5D	25	0.419	0.339	809	274	0.475	-	3.57
			35	0.419	0.333	795	265	0.460	-	3.44
			45	0.419	0.325	776	252	0.444	-	3.27
			60	0.419	0.312	745	232	0.417	840	3.02
	37	117-6-5-5C	25	0.423	0.352	831	293	0.459	-	3.80
			35	0.423	0.348	822	286	0.444	-	3.72
			45	0.423	0.330	779	257	0.428	-	3.34
			60	0.423	0.310	732	227	0.409	835	2.95
D CONTROL CELLS	String	119-8-6-4E 128-7-4-3D 128-8-5-7E 129-3-5-3A 129-8-6-2B 130-7-6-3B	25	3.615	2.238	619	1,386	2.848	690	3.00
			-							
			-							
			-							
	44	130-4-4-5A	25	0.503	0.367	730	268	0.469	830	3.48
			-							
			-							
			-							
	45	135-5-1-3D	25	0.526	0.368	700	258	0.476	780	3.35
			-							
			-							
			-							
	46	130-4-4-6A	25	0.568	0.370	651	241	0.467	740	3.13
			-							
			-							
			-							

Table A-10: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
E	56	64265	25	0.534	0.342	640	219	0.468	-	2.85
			35	0.534	0.337	631	213	0.452	-	2.77
			45	0.534	0.329	616	202	0.436	-	2.63
			55	0.534	0.323	605	195	0.420	696	2.54
	57	64445	25	0.500	0.321	642	206	0.457	-	2.68
			35	0.500	0.317	634	201	0.443	-	2.61
			45	0.500	0.310	620	192	0.428	-	2.50
			55	0.500	0.304	608	185	0.412	685	2.41
	58	72559	25	0.534	0.341	639	218	0.471	-	2.83
			35	0.534	0.336	629	211	0.453	-	2.74
			45	0.534	0.329	616	203	0.436	-	2.64
			55	0.534	0.322	603	194	0.419	695	2.52
	59	81156	25	0.526	0.353	671	237	0.480	-	3.08
			35	0.526	0.348	662	230	0.462	-	2.99
			45	0.526	0.343	652	224	0.444	-	2.91
			55	0.526	0.333	633	210	0.426	720	2.73
	60	82251	25	0.541	0.353	652	230	0.468	-	2.99
			35	0.541	0.346	640	221	0.454	-	2.87
			45	0.541	0.340	628	214	0.440	-	2.78
			55	0.541	0.330	610	201	0.425	700	2.61
	61	299861C	25	0.464	0.351	756	265	0.467	-	3.44
			35	0.464	0.343	739	253	0.453	-	3.29
			45	0.464	0.335	722	242	0.439	-	3.15
			55	0.464	0.324	698	226	0.423	830	2.94
	62	300861F	25	0.449	0.334	744	248	0.465	-	3.22
			35	0.449	0.330	735	243	0.449	-	3.16
			45	0.449	0.321	715	230	0.433	-	2.99
			55	0.449	0.310	691	214	0.417	800	2.78
	63	298644D	25	0.455	0.339	745	253	0.472	-	3.29
			35	0.455	0.334	734	245	0.456	-	3.19
			45	0.455	0.325	714	232	0.440	-	3.02
			55	0.455	0.313	688	215	0.425	800	2.80
	64	300867F	25	0.442	0.335	758	254	0.464	-	3.30
			35	0.442	0.330	747	247	0.450	-	3.21
			45	0.442	0.322	729	235	0.435	-	3.06
			55	0.442	0.312	706	220	0.421	820	2.86

Table A-11: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
F	47	N361CK2	25	0.560	0.345	616	213	0.452	-	2.77
			35	0.560	0.340	607	206	0.439	-	2.68
			45	0.560	0.333	595	196	0.425	-	2.55
			55	0.560	0.325	580	189	0.411	661	2.46
	48	N362CK7	25	0.545	0.343	629	216	0.458	-	2.81
			35	0.545	0.337	618	208	0.442	-	2.70
			45	0.545	0.330	606	200	0.427	-	2.60
			55	0.545	0.323	593	192	0.411	699	2.50
	49	N359AK6	25	0.485	0.322	664	214	0.447	-	2.78
			35	0.485	0.317	654	207	0.431	-	2.69
			45	0.485	0.313	645	202	0.415	-	2.63
			55	0.485	0.307	633	194	0.400	722	2.52
	50	81762	25	0.511	0.335	656	220	0.454	-	2.86
			35	0.511	0.331	648	214	0.439	-	2.78
			45	0.511	0.325	636	207	0.424	-	2.69
			55	0.511	0.317	620	197	0.409	710	2.56
	51	81763	25	0.480	0.338	704	238	0.451	-	3.09
			35	0.480	0.335	698	234	0.438	-	3.04
			45	0.480	0.327	681	223	0.424	-	2.90
			55	0.480	0.320	666	213	0.410	782	2.77
	52	301544D	25	0.488	0.343	703	241	0.463	-	3.13
			35	0.488	0.336	689	232	0.447	-	3.02
			45	0.488	0.327	670	219	0.433	-	2.85
			55	0.488	0.317	650	206	0.419	770	2.68
	53	300143D	25	0.478	0.348	728	253	0.476	-	3.29
			35	0.478	0.343	718	246	0.460	-	3.20
			45	0.478	0.334	699	233	0.444	-	3.03
			55	0.478	0.324	678	220	0.428	795	2.86
	54	294446D	25	0.447	0.335	749	251	0.455	-	3.26
			35	0.447	0.327	732	239	0.440	-	3.11
			45	0.447	0.318	711	226	0.425	-	2.94
			55	0.447	0.307	687	211	0.411	819	2.74
	55	298767C	25	0.471	0.339	720	244	0.456	-	3.17
			35	0.471	0.331	703	233	0.442	-	3.03
			45	0.471	0.320	679	217	0.428	-	2.82
			55	0.471	0.313	665	208	0.413	795	2.70

Table A-12: PRECYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification: Boeing No.	Cell Identification: Mfg No.	Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
E & F CONTROL CELLS	65	N365BK5	25	0.403	0.326	809	264	0.450	-	3.43
			35	0.403	0.323	801	259	0.435	-	3.37
			45	0.403	0.314	780	245	0.421	-	3.19
			55	0.403	0.305	756	231	0.407	872	3.00
	66	N362CK9	25	0.527	0.353	670	237	0.470	-	3.08
			35	0.527	0.348	660	230	0.457	-	2.99
			45	0.527	0.339	643	218	0.443	-	2.83
			55	0.527	0.329	619	204	0.428	715	2.65
	67	72557	25	0.452	0.331	732	242	0.456	-	3.15
			35	0.452	0.326	721	235	0.441	-	3.06
			45	0.452	0.319	706	225	0.426	-	2.93
			55	0.452	0.313	692	217	0.412	750	2.82
	68	87841	25	0.510	0.327	641	210	0.435	-	2.73
			35	0.510	0.322	631	203	0.422	-	2.64
			45	0.510	0.315	618	194	0.409	-	2.52
			55	0.510	0.297	582	173	0.395	694	2.25
	69	81868	25	0.480	0.337	702	237	0.457	-	3.08
			35	0.480	0.331	690	228	0.443	-	2.96
			45	0.480	0.323	673	217	0.429	-	2.82
			55	0.480	0.313	652	204	0.415	755	2.65
	70	83147	25	0.532	0.340	639	217	0.470	-	2.82
			35	0.532	0.332	624	207	0.452	-	2.69
			45	0.532	0.325	611	199	0.434	-	2.59
			55	0.532	0.319	600	191	0.417	690	2.48
	71	299541A	25	0.503	0.347	690	239	0.472	-	3.11
			35	0.503	0.339	674	228	0.455	-	2.96
			45	0.503	0.329	654	215	0.439	-	2.80
			55	0.503	0.322	640	206	0.423	751	2.68
	72	298556E	25	0.503	0.331	658	218	0.447	-	2.83
			35	0.503	0.324	644	209	0.433	-	2.72
			45	0.503	0.314	624	196	0.419	-	2.55
			55	0.503	0.306	608	186	0.405	710	2.42
	73	302366C	25	0.449	0.337	751	253	0.469	-	3.29
			35	0.449	0.332	739	245	0.454	-	3.19
			45	0.449	0.324	721	234	0.440	-	3.04
			55	0.449	0.314	700	220	0.425	815	2.86

Table A-13: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Fill Factor (%)	Voltage at Max Power (volts)	Current at Max Power (ma)	Max Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
A	1	N153AK7	-- -- -- 60	66.1	0.308	666	205	0.425	730	2.67
	2	N319BK2	-- -- -- 60	60.3	0.300	665	200	0.425	780	2.61
	3	N310CK9	-- -- -- 60	55.5	0.316	539	170	0.435	704	2.22
	4	N315BK4	-- -- -- 60	66.4	0.317	644	204	0.420	731	2.66
	5	N311BK5	-- -- -- 60	63.8	0.311	649	202	0.420	754	2.64

Measurement Condition:
- In air, with cell mounted on a temperature-controlled block
- Light intensity = AMO

Table A-14: POSTCYCLING PERFORMANCE FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temp (°C)	Load Resis-tance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Effi-ciency (%)
	Boeing No.	Mfg No.								
B TEST CELLS	6	N319BK4	25	0.519	0.339	653	221	0.491	-	2.88
			35	0.519	0.328	632	207	0.475	-	2.69
			45	0.519	0.319	615	196	0.458	-	2.55
			60	0.519	0.300	578	173	0.434	748	2.25
	7	N310BK7	25	0.576	0.356	618	220	0.482	-	2.86
			35	0.576	0.347	603	209	0.469	-	2.72
			45	0.576	0.335	582	195	0.455	-	2.53
			60	0.576	0.316	549	173	0.434	700	2.25
	8	N315BK1	25	0.549	0.340	620	211	0.473	-	2.74
			35	0.549	0.333	607	202	0.458	-	2.63
			45	0.549	0.325	592	192	0.443	-	2.50
			60	0.549	0.310	656	175	0.421	670	2.28
	9	N311AK1	25	0.546	0.342	626	214	0.476	-	2.78
			35	0.546	0.333	609	203	0.462	-	2.64
			45	0.546	0.324	593	192	0.447	-	2.50
			60	0.546	0.306	560	171	0.426	700	2.23
B CONTROL CELLS	15	N321BK3	25	0.465	0.347	747	259	0.472	-	3.37
			35	0.465	0.339	730	247	0.455	-	3.21
			45	0.465	0.331	712	236	0.437	-	3.06
			60	0.465	0.315	678	214	0.410	820	2.78
	16	N318BK6	25	0.453	0.314	693	218	0.439	-	2.83
			35	0.453	0.310	684	212	0.425	-	2.76
			45	0.453	0.306	675	206	0.411	-	2.68
			60	0.453	0.296	653	193	0.390	750	2.51
	17	N311CK6	25	0.480	0.323	673	218	0.472	-	2.83
			35	0.480	0.319	665	212	0.455	-	2.76
			45	0.480	0.315	657	207	0.437	-	2.69
			60	0.480	0.306	638	195	0.410	730	2.54
	18	N317BK5	25	0.461	0.321	697	224	0.442	-	2.91
			35	0.461	0.316	686	217	0.426	-	2.82
			45	0.461	0.311	675	210	0.411	-	2.73
			60	0.461	0.299	649	194	0.387	760	2.52

Table A-15: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Load Resis-tance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Effi-ciency (%)
	Boeing No.	Mfg No.								
C	19	91154	25	0.630	0.339	538	182	0.473	-	2.37
			35	0.630	0.324	515	167	0.457	-	2.17
			45	0.630	0.311	494	154	0.442	-	2.00
			60	0.630	0.289	459	133	0.420	670	1.72
	20	91746	25	0.717	0.349	487	170	0.491	-	2.21
			35	0.717	0.338	472	159	0.476	-	2.07
			45	0.717	0.324	452	146	0.460	-	1.90
			60	0.717	0.301	420	126	0.438	590	1.64
	21	88861	25	9.647	0.350	541	189	0.491	-	2.46
			35	0.647	0.336	519	174	0.476	-	2.27
			45	0.647	0.324	500	162	0.461	-	2.11
			60	0.647	0.301	465	140	0.439	621	1.82
	22	81-8-6-5	25	0.523	0.339	648	220	0.475	-	2.86
			35	0.523	0.332	635	211	0.460	-	2.74
			45	0.523	0.322	616	198	0.444	-	2.58
			60	0.523	0.308	589	181	0.420	739	2.36
	23	82-1-4-5	25	0.502	0.336	669	225	0.478	-	2.92
			35	0.502	0.327	651	213	0.462	-	2.77
			45	0.502	0.318	633	201	0.448	-	2.62
			60	0.502	0.301	599	180	0.426	809	2.34

Table A-16: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
C	24	93154	25	0.440	0.325	738	240	0.447	-	3.12
			35	0.440	0.319	725	231	0.431	-	3.00
			45	0.440	0.311	706	220	0.414	-	2.86
			60	0.440	0.298	677	202	0.389	809	2.62
	25	89641	25	0.541	0.347	642	223	0.481	-	2.89
			35	0.541	0.345	638	220	0.464	-	2.86
			45	0.541	0.338	625	211	0.448	-	2.75
			60	0.541	0.325	601	195	0.423	690	2.54
	26	88867	25	0.514	0.336	654	220	0.468	-	2.85
			35	0.514	0.329	640	210	0.452	-	2.74
			45	0.514	0.321	624	200	0.437	-	2.60
			60	0.514	0.309	601	186	0.413	715	2.41
	27	81-7-6-3	25	0.445	0.325	730	237	0.451	-	3.09
			35	0.445	0.322	724	233	0.437	-	3.03
			45	0.445	0.316	710	224	0.424	-	2.92
			60	0.445	0.307	690	212	0.405	780	2.75
	28	81-1-5-9	25	0.419	0.336	802	270	0.455	-	3.50
			35	0.419	0.328	783	257	0.440	-	3.34
			45	0.419	0.321	766	246	0.426	-	3.20
			60	0.419	0.307	733	225	0.405	868	2.92

Table A-17: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
D TEST CELLS	String	117-6-5-9C 117-7-4-8D 119-7-4-6D 119-8-6-8E 119-8-6-7E 130-7-6-2B	60	3.689	1.900	515	978	2.575	630	2.12
	35	130-4-4-4A	25	0.571	0.345	604	208	0.483	-	2.71
			35	0.571	0.331	580	192	0.465	-	2.49
			45	0.571	0.318	557	177	0.448	-	2.30
			60	0.571	0.297	520	154	0.421	656	2.01
	36	119-7-4-5D	25	0.586	0.339	578	196	0.492	-	2.55
			35	0.586	0.332	566	188	0.474	-	2.44
			45	0.586	0.320	546	175	0.456	-	2.27
			60	0.586	0.299	510	152	0.429	685	1.98
	37	117-6-5-5C	25	0.423	0.308	728	224	0.439	-	2.91
			35	0.423	0.297	702	208	0.424	-	2.71
			45	0.423	0.290	685	199	0.410	-	2.58
			60	0.423	0.275	650	179	0.388	765	2.32
D CONTROL CELLS	String	119-8-6-4E 128-7-4-3D 128-8-5-7E 129-3-5-3A 129-8-6-2B 130-7-6-3B	25	3.710	2.200	593	1,305	2.825	658	2.83
	44	130-4-4-5A	25	0.448	0.330	737	243	-	-	3.16
			35	0.448	0.324	724	234	-	-	3.05
			45	0.448	0.318	710	226	-	-	2.94
			60	0.448	0.304	679	206	0.402	790	2.68
	45	135-5-1-3D	25	0.501	0.343	685	235	-	-	3.05
			35	0.501	0.338	675	228	-	-	2.96
			45	0.501	0.330	659	217	-	-	2.83
			60	0.501	0.315	629	198	0.411	735	2.58
	46	130-4-4-6A	25	0.495	0.343	693	238	-	-	3.09
			35	0.495	0.338	683	231	-	-	3.00
			45	0.495	0.330	666	220	-	-	2.86
			60	0.495	0.307	620	190	0.404	710	2.47

Table A-18: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification Boeing No.	Cell Identification Mfg No.	Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
E	56	64265	25	0.575	0.339	589	200	0.468	-	2.60
			35	0.575	0.334	580	194	0.460	-	2.52
			45	0.575	0.326	566	185	0.445	-	2.40
			55	0.575	0.324	563	182	0.435	670	2.37
	57	64445	25	0.619	0.337	544	183	0.456	-	2.38
			35	0.619	0.334	539	180	0.454	-	2.34
			45	0.619	0.329	531	175	0.447	-	2.27
			55	0.619	0.329	531	175	0.443	660	2.27
	58	72559	25	0.607	0.353	581	205	0.463	-	2.66
			35	0.607	0.341	562	191	0.452	-	2.48
			45	0.607	0.335	552	185	0.440	-	2.40
			55	0.607	0.326	537	175	0.431	665	2.28
	59	81156	25	0.558	0.357	639	228	0.491	-	2.96
			35	0.558	0.350	627	219	0.476	-	2.85
			45	0.558	0.343	614	211	0.461	-	2.74
			55	0.558	0.335	600	201	0.445	709	2.61
	60	82251	25	0.573	0.361	629	227	0.493	-	2.95
			35	0.573	0.352	614	216	0.477	-	2.81
			45	0.573	0.342	596	204	0.462	-	2.65
			55	0.573	0.332	579	192	0.446	683	2.50
	61	299861C	25	0.548	0.364	664	242	0.492	-	3.15
			35	0.548	0.352	642	226	0.476	-	2.94
			45	0.548	0.339	618	210	0.462	-	2.73
			55	0.548	0.324	591	191	0.445	755	2.48
	62	300861F	25	0.509	0.345	678	234	0.482	-	3.04
			35	0.509	0.337	662	223	0.468	-	2.90
			45	0.509	0.324	637	206	0.452	-	2.68
			55	0.509	0.315	619	195	0.435	766	2.54
	63	298644D	25	0.588	0.354	602	213	0.489	-	2.77
			35	0.588	0.343	584	200	0.475	-	2.60
			45	0.588	0.327	556	182	0.458	-	2.37
			55	0.588	0.315	536	169	0.441	705	2.20
	64	300867F	25	0.555	0.356	641	228	0.488	-	2.96
			35	0.555	0.347	625	217	0.474	-	2.82
			45	0.555	0.332	598	199	0.457	-	2.59
			55	0.555	0.323	582	188	0.442	750	2.44

Table A-19: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temp (°C)	Load Resis-tance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Effi-ciency (%)
	Boeing No.	Mfg No.								
F	47	N361CK2	25	0.638	0.363	567	206	0.479	-	2.68
			35	0.638	0.354	554	196	0.466	-	2.55
			45	0.638	0.342	535	183	0.455	-	2.38
			55	0.638	0.332	520	173	0.438	625	2.25
	48	N362CK7	25	0.628	0.364	579	211	0.490	-	2.74
			35	0.628	0.355	565	201	0.474	-	2.61
			45	0.628	0.345	549	189	0.462	-	2.46
			55	0.628	0.333	530	177	0.443	649	2.30
	49	N359AK6	25	0.596	0.362	607	220	0.477	-	2.86
			35	0.596	0.352	590	208	0.462	-	2.70
			45	0.596	0.338	567	192	0.449	-	2.50
			55	0.596	0.328	550	180	0.434	662	2.34
	50	81762	25	0.619	0.369	596	220	0.492	-	2.86
			35	0.619	0.356	575	205	0.475	-	2.66
			45	0.619	0.341	551	188	0.460	-	2.44
			55	0.619	0.327	528	173	0.442	665	2.25
	51	81763	25	0.553	0.356	643	229	0.475	-	2.98
			35	0.553	0.348	629	219	0.463	-	2.85
			45	0.553	0.339	613	208	0.450	-	2.70
			55	0.553	0.322	582	187	0.435	710	2.43
	52	301544D	25	0.625	0.357	571	204	0.489	-	2.65
			35	0.625	0.345	552	190	0.474	-	2.47
			45	0.625	0.329	526	173	0.459	-	2.25
			55	0.625	0.317	507	161	0.443	652	2.09
	53	300143D	25	0.567	0.353	622	220	0.496	-	2.86
			35	0.567	0.342	603	206	0.480	-	2.68
			45	0.567	0.328	578	190	0.467	-	2.47
			55	0.567	0.313	552	173	0.447	690	2.25
	54	294446D	25	0.600	0.353	589	208	0.488	-	2.70
			35	0.600	0.339	565	192	0.474	-	2.50
			45	0.600	0.326	544	177	0.461	-	2.30
			55	0.600	0.310	517	160	0.444	690	2.08
	55	298767C	25	0.579	0.355	613	218	0.484	-	2.83
			35	0.579	0.343	592	203	0.469	-	2.64
			45	0.579	0.329	568	187	0.454	-	2.43
			55	0.579	0.314	542	170	0.436	705	2.21

Table A-20: POSTCYCLING PERFORMANCE DATA FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temp (°C)	Load Resistance (ohms)	Voltage at Load Power (volts)	Current at Load Power (ma)	Load Power (mw)	Open Circuit Voltage (volts)	Short Circuit Current (ma)	Efficiency (%)
	Boeing No.	Mfg No.								
CONTROL CELLS	65	N365BK5	25	0.410	0.337	821	277	0.451	-	3.60
			35	0.410	0.327	797	261	0.437	-	3.39
			45	0.410	0.317	772	245	0.424	-	3.18
			55	0.410	0.307	748	230	0.409	860	2.99
	66	N362CK9	25	0.557	0.360	646	233	0.470	-	3.02
			35	0.557	0.352	632	222	0.457	-	2.89
			45	0.557	0.344	618	212	0.442	-	2.76
			55	0.557	0.333	598	199	0.426	692	2.59
	67	72557	25	0.488	0.340	696	237	0.457	-	3.08
			35	0.488	0.332	680	226	0.441	-	2.93
			45	0.488	0.327	669	219	0.429	-	2.84
			55	0.488	0.317	649	206	0.413	755	2.67
	68	87841	25	0.524	0.322	614	198	0.447	-	2.57
			35	0.524	0.315	601	189	0.434	-	2.46
			45	0.524	0.310	591	183	0.420	-	2.38
			55	0.524	0.304	580	176	0.399	691	2.29
	69	81868	25	0.500	0.346	692	239	0.458	-	3.11
			35	0.500	0.338	676	228	0.448	-	2.97
			45	0.500	0.329	658	216	0.433	-	2.81
			55	0.500	0.320	640	205	0.418	749	2.66
	70	83147	25	0.548	0.338	616	208	0.458	-	2.71
			35	0.548	0.331	603	200	0.448	-	2.60
			45	0.548	0.325	592	192	0.434	-	2.50
			55	0.548	0.322	587	189	0.417	690	2.46
	71	299541A	25	0.485	0.343	708	243	0.471	-	3.16
			35	0.485	0.334	689	230	0.455	-	2.99
			45	0.485	0.325	670	218	0.441	-	2.83
			55	0.485	0.318	656	209	0.426	755	2.71
	72	298556E	25	0.507	0.332	654	217	0.453	-	2.82
			35	0.507	0.325	640	208	0.437	-	2.70
			45	0.507	0.317	625	198	0.422	-	2.57
			55	0.507	0.307	605	186	0.408	700	2.41
	73	302366C	25	0.456	0.339	744	252	0.469	-	3.28
			35	0.456	0.334	733	245	0.453	-	3.18
			45	0.456	0.325	713	232	0.439	-	3.01
			55	0.456	0.315	691	218	0.422	807	2.83

Table A-21: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(1) Maximum Power (mW/°C)
A	1	N153AK7	-1.5	NOT MEASURED	-1.4
	2	N319BK2	-1.6	NOT MEASURED	-1.4
	3	N310CK9	-1.6	NOT MEASURED	-1.2
	4	N315BK4	-1.5	NOT MEASURED	-1.0
	5	N311BK5	-1.2	-0.9	-0.7
	10	N152BK7	-1.6	NOT MEASURED	-1.5
	11	N320BK4	-1.5	NOT MEASURED	-1.2
	12	N310CK5	-1.4	NOT MEASURED	-1.1
	13	N315CK6	-1.5	NOT MEASURED	-1.0
	14	N311CK8	-1.6	-1.0	-1.2

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-22: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
B	6	N319BK4	-1.5	-0.8	-1.2
	7	N310BK7	-1.4	-0.6	-0.8
	8	N315BK1	-1.4	-0.5	-0.7
	9	N311AK1	-1.4	-0.7	-0.9
	15	N321BK3	-1.7	-1.0	-1.3
	16	N318BK6	-1.4	-0.8	-1.0
	17	N311CK6	-1.8	-1.1	-1.5
	18	N317BK5	-1.5	-0.9	-1.2

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-23: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
C	19	91154	-1.4	-1.0	-1.3
	20	91746	-1.6	-1.1	-1.3
	21	88861	-1.5	-0.9	-1.2
	22	81865	-1.6	-0.9	-1.2
	23	82045	-1.4	-0.9	-1.5
	24	93154	-1.6	-1.1	-1.5
	25	89641	-1.4	-1.1	-1.3
	26	88867	-1.6	-1.2	-1.2
	27	81-7-6-3	-1.3	-1.0	-1.3
	28	81-1-5-9	-1.4	-1.0	-1.6

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-24: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
D	STRING	119-7-4-6D 117-7-4-8D 117-6-5-9C 119-8-6-8E 119-8-6-7E 130-7-6-2B	-8.7	-12.1	-16.75
	35	130-4-4-4A	-1.7	-1.1	-1.5
	36	119-7-4-5D	-1.8	-0.9	-1.3
	37	117-6-5-5C	-1.3	-1.3	-2.0

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-25: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
E	56	64265	-1.6	-0.6	-0.7
	57	64445	-1.5	-0.6	-0.7
	58	72559	-1.7	-0.7	-0.9
	59	81156	-1.8	-1.0	-1.4
	60	82251	-1.4	-1.0	-1.3
	61	299861C	-1.4	-1.1	-1.6
	62	300861F	-1.6	-1.1	-1.6
	63	298644D	-1.6	-1.2	-1.7
	64	300867F	-1.4	-1.0	-1.5

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-26: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	△1 Open-Circuit Voltage (mV/°C)	△2 Load Voltage (mV/°C)	△3 Load Power (mW/°C)
F	47	N361CK2	-1.4	-0.8	-0.7
	48	N362CK7	-1.6	-0.7	-0.8
	49	N359AK6	-1.6	-0.6	-0.8
	50	81762	-1.5	-0.8	-1.0
	51	81763	-1.4	-0.7	-1.0
	52	301544D	-1.4	-1.0	-1.3
	53	300143D	-1.6	-1.0	-1.3
	54	294446D	-1.5	-1.0	-1.5
	55	298767C	-1.4	-0.7	-0.9

△1 Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

△2 Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

△3 Calculated from $P_L = V_L^2/R_L$

Table A-27: PRECYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
E & F CONTROL CELLS	65	N365BK5	-1.4	-0.9	-1.4
	66	N362CK9	-1.4	-1.0	-1.4
	67	72557	-1.5	-0.6	-0.8
	68	87841	-1.3	-1.8	-2.1
	69	81868	-1.4	-1.0	-1.3
	70	83147	-1.8	-0.6	-0.8
	71	299541A	-1.6	-0.7	-0.9
	72	298556E	-1.4	-0.8	-1.0
	73	302366C	-1.5	-1.0	-1.4

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-28: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	1 Open-Circuit Voltage (mV/°C)	2 Load Voltage (mV/°C)	3 Load Power (mW/°C)
B	6	N319BK4	-1.6	-1.1	-1.4
	7	N310BK7	-1.4	-1.1	-1.3
	8	N315BK1	-1.5	-0.8	-1.0
	9	N311AK1	-1.4	-1.0	-1.2
	15	N321BK3	-1.8	-0.9	-1.3
	16	N318BK6	-1.4	-0.5	-0.7
	17	N311CK6	-1.8	-0.5	-0.6
	18	N317BK5	-1.6	-0.6	-0.8

1 Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

2 Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

3 Calculated from $P_L = V_L^2/R_L$

Table A-29: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST AND CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
C	19	91154	-1.5	-1.4	-1.4
	20	91746	-1.5	-1.4	-1.2
	21	88861	-1.5	-1.4	-1.4
	22	81-8-6-5	-1.6	-0.9	-1.1
	23	82-1-4-5	-1.5	-1.0	-1.3
	24	93154	-1.6	-0.8	-1.1
	25	89641	-1.6	-0.6	-0.8
	26	88867	-1.6	-0.8	-1.0
	27	81-7-6-3	-1.3	-0.5	-0.7
	28	81-1-5-9	-1.4	-0.8	-1.3

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-30: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	1 Open-Circuit Voltage (mV/°C)	2 Load Voltage (mV/°C)	3 Load Power (mW/°C)
D	STRING	117-6-5-9C			
		117-7-4-8D			
		119-7-4-6D			
		119-8-6-8E			
		119-8-6-7E			
		130-7-6-2B			
	35	130-4-4-4A	-1.8	-1.4	-1.5
	36	119-7-4-5D	-1.8	-1.1	-1.2
	37	117-6-5-5C	-1.4	-0.9	-1.3

1 Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

2 Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

3 Calculated from $P_L = V_L^2/R_L$

Table A-31: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
D	STRING	119-8-6-4E			
		128-7-4-3D			
		128-8-5-7E			
		129-3-5-3A			
		129-8-6-2B			
		130-7-6-3B			
	44	130-4-4-5A	NOT MEASURED	-0.7	-1.0
	45	135-5-1-3D	NOT MEASURED	-0.8	-1.0
	46	130-4-4-6A	NOT MEASURED	-1.0	-1.4

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 60°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-32: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
E	56	64265	-1.1	-0.5	-0.6
	57	64445	-0.4	-0.3	-0.3
	58	72559	-1.1	-0.9	-1.0
	59	81156	-1.5	-0.7	-0.9
	60	82251	-1.6	-1.0	-1.2
	61	299861C	-1.6	-1.3	-1.7
	62	300861F	-1.6	-1.0	-1.3
	63	298644D	-1.6	-1.3	-1.5
	64	300867F	-1.5	-1.1	-1.3

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-33: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE TEST CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
F	47	N361CK2	-1.4	-1.0	-1.1
	48	N362CK7	-1.6	-1.0	-1.1
	49	N359AK6	-1.4	-1.1	-1.3
	50	81762	-1.7	-1.4	-1.6
	51	81763	-1.3	-1.1	-1.4
	52	301544D	-1.5	-1.3	-1.4
	53	300143D	-1.6	-1.3	-1.6
	54	294446D	-1.5	-1.4	-1.6
	55	298767C	-1.6	-1.4	-1.6

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

Table A-34: POSTCYCLING TEMPERATURE COEFFICIENTS FOR CADMIUM SULFIDE CONTROL CELLS

Group	Cell Identification		Temperature Coefficients		
	Boeing No.	Mfg No.	(1) Open-Circuit Voltage (mV/°C)	(2) Load Voltage (mV/°C)	(3) Load Power (mW/°C)
E & F CONTROL CELLS	65	N365BK5	-1.4	-1.0	-1.6
	66	N362CK9	-1.5	-0.9	-1.1
	67	72557	-1.5	-0.8	-1.0
	68	87841	-1.6	-0.6	-0.7
	69	81868	-1.3	-0.9	-1.1
	70	83147	-1.4	-0.5	-0.6
	71	299541A	-1.5	-0.8	-1.1
	72	298556E	-1.5	-0.8	-1.0
	73	302366C	-1.6	-0.8	-1.1

(1) Obtained from I-V curves with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C. Light intensity was at AMO.

(2) Obtained from voltages at cell electrodes with cell mounted on a temperature controlled block at 25, 35, 45, and 55°C while a constant load resistance (R_L) was placed across the cell electrodes. Light intensity was at AMO.

(3) Calculated from $P_L = V_L^2/R_L$

9.0 NEW TECHNOLOGY

No new technology was developed during the contract period.